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FOUNDRY TRADE JOURNAL

AND PATTERN-MAKER.

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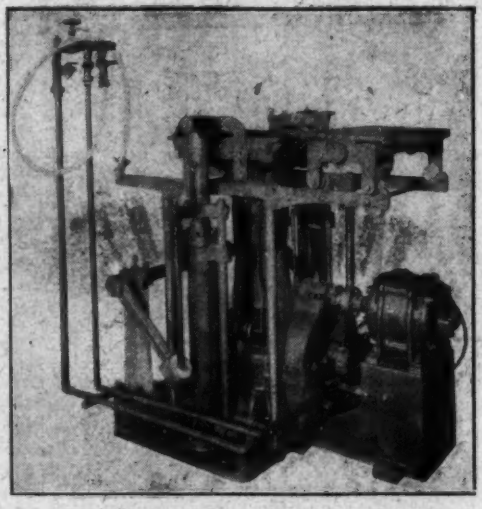

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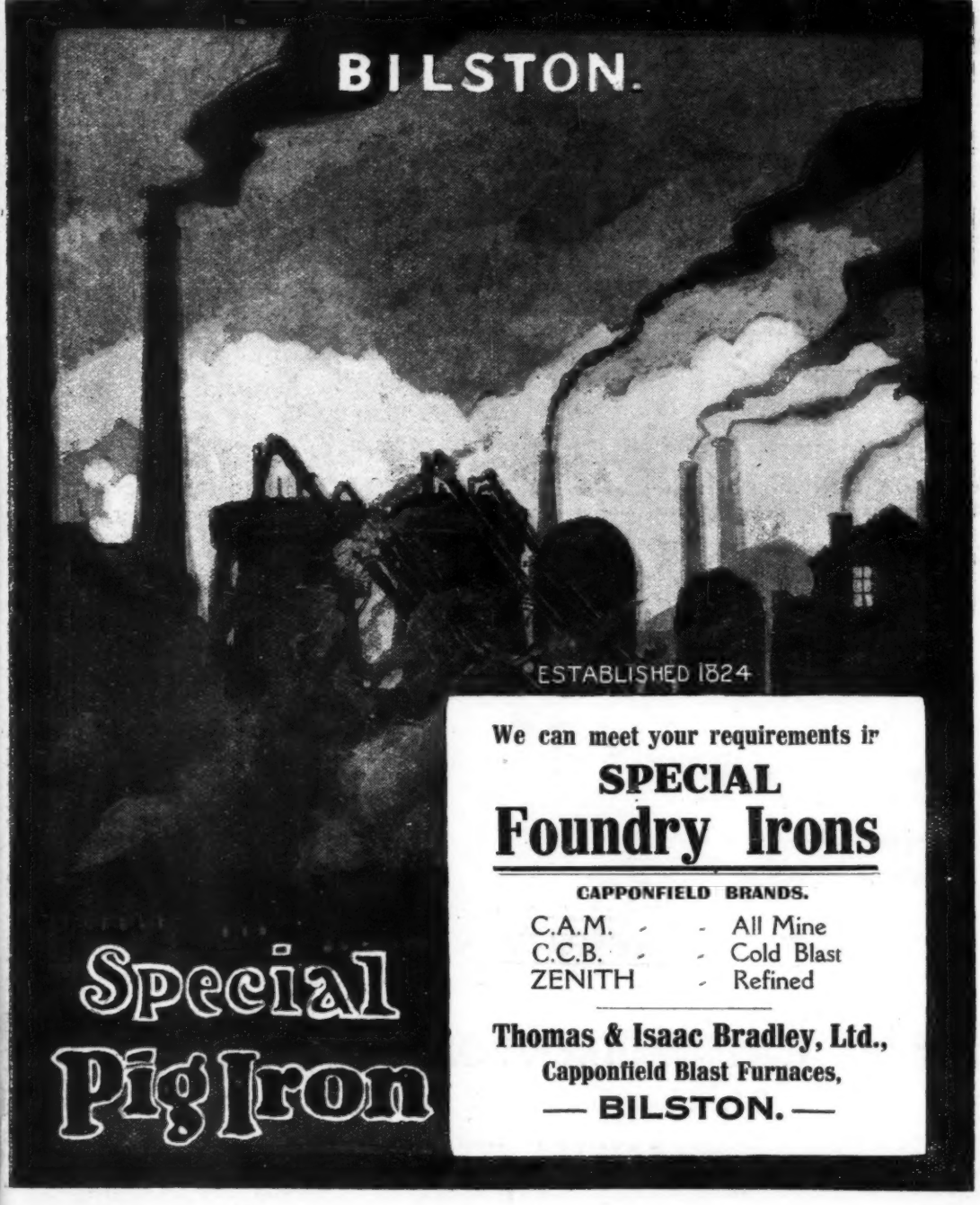

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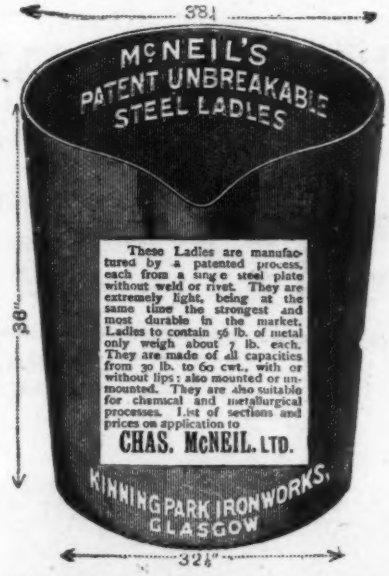
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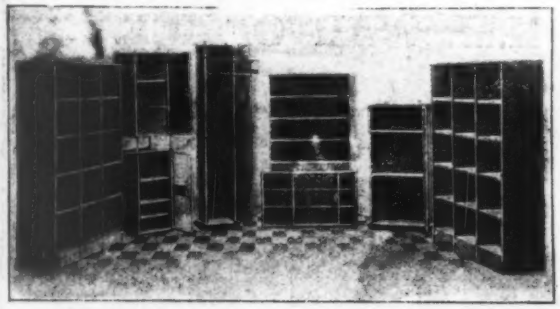

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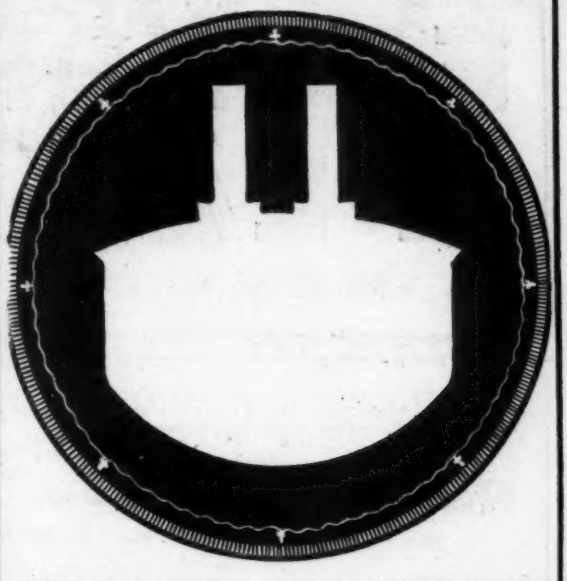

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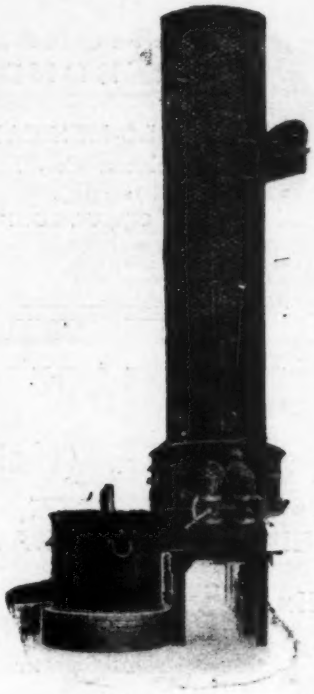

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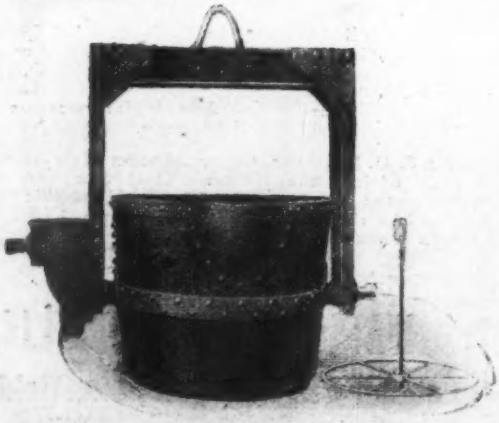

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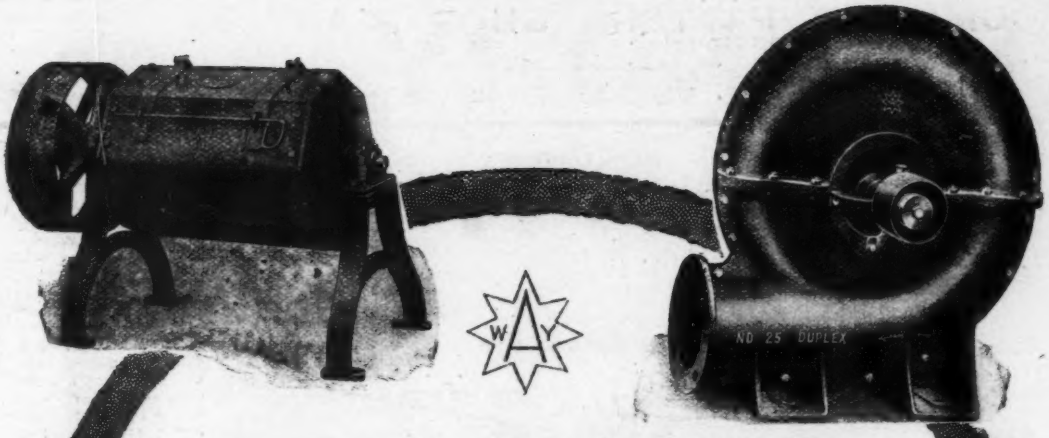

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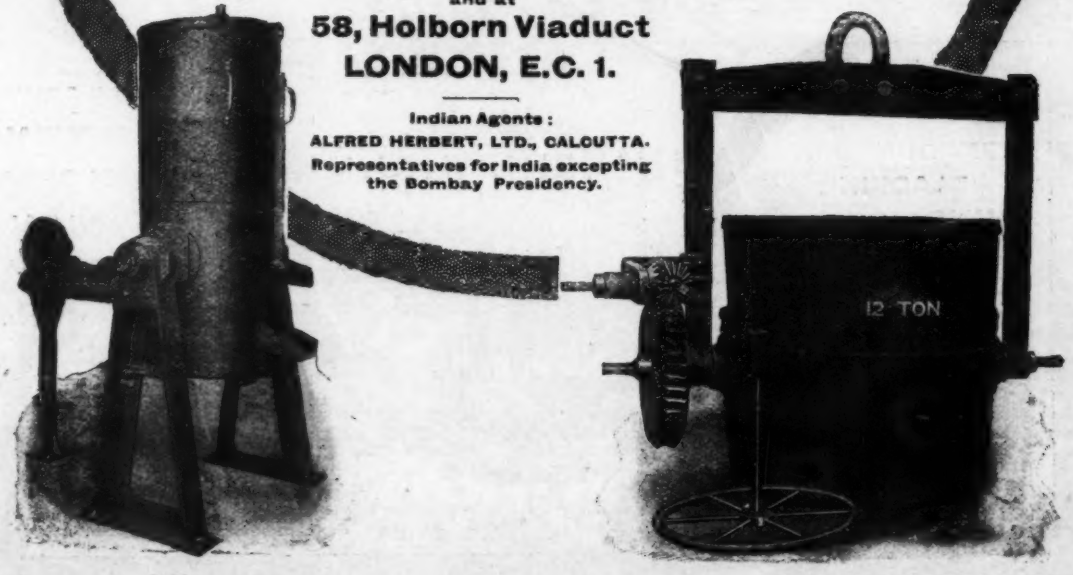

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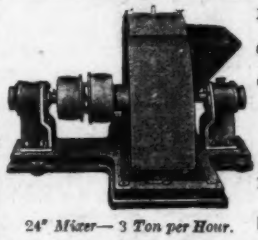

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The Foundry Trade Journal
AND PATTERN MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

Vol. 20. JANUARY, 1918. No. 193.

PUBLISHED THE FIRST WEEK IN EACH MONTH

Subscription Terms: 7s. 6d. per annum, post free.

To place the "Journal" within the reach of working Moulders and Pattern-makers, the Proprietors will accept subscriptions, not less than three in number from one shop, at the reduced rate of 5s per annum, such order to be countersigned by the superintendent or foreman.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

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Forthcoming Events.

JANUARY 11.

British Foundrymen's Association (London Branch):—"Stamping Qualities of Copper-Zinc Alloys," by J. Grout (Luton).

JANUARY 12.

British Foundrymen's Association (Lancashire Branch):—"Melting Copper Alloys," by H. L. Reason (Birmingham).

British Foundrymen's Association (Scottish Branch):—"Cast-iron from an Engineer's Standpoint," by Prof. R. L. Mallanby, D.Sc., M.I.Mech.E.

JANUARY 18.

British Foundrymen's Association (Sheffield Branch):—"Refractory Materials," by Prof. Fearnsides, M.A.

JANUARY 26.

British Foundrymen's Association (Birmingham Branch):—"Some Observations from the Use of Iron Moulds," by M. Riddell (Glasgow).

British Foundrymen's Association (East Midlands Branch):—"The Foundry Cupola," by E. L. Rhead (Manchester).

British Foundrymen's Association (Newcastle Branch):—Lecture on "The Late John Surtees," by R. Wallis.

NOTES AND COMMENTS.

A Foundry Technical Bureau.

For years we have insisted on the necessity of co-ordinating ideas on foundry technology and gathering into usable form the mass of scattered but valuable information that already exists on founding and foundry metallurgy. At present the founder has no place to which he can turn to secure immediate and reliable data and information on the problems he meets daily, though generally this information is available if he knew where to find it. The process of collecting and collating available data on the craft, however, is not a work for any individual to undertake unaided, but requires the moral support and practical assistance of representative institutions, such as the British Foundrymen's Association. We have urged that this work should be made a prominent feature of the Association's activities, but so far the suggestion has not borne fruit. Efforts have been made recently in Birmingham to secure greater co-operation in scientific and technical matters in connection with non-ferrous industries, and at a recent meeting of the Local Section of the Institute of Metals Mr. Stanley Evered described a scheme for co-operative employment of laboratories. The movement was carried a step further last month when representatives of about fifty non-ferrous metal firms in Birmingham and district met at the Chamber of Commerce. The meeting was convened by a circular signed by Mr. J. W. Madeley (Chairman of the Brassmasters' Association), Mr. John W. Earle (Chairman of the Metal Section of the Chamber of Commerce), and Mr. R. Stanley Evered (Chairman of the Birmingham Local Section of the Institute of Metals).

The circular outlined a suggested Bureau of Scientific Information bearing upon the non-ferrous trades and working on co-operative lines. The idea is to collect matter published by the world's technical and scentific Press in any language for distribution to co-operative firms, to collect from such firms information of general value relating to efficiency of methods of manufacture, technical processes, laboratory organisation, with application to works practice and specific researches of matters of interest to the trade. It is hoped, in brief, by such a scheme, to establish what may be termed departments of reference for the non-ferrous industry which will furnish them with a means of obtaining quickly, accurately, and conveniently technical and scientific information such as will enable them to reach the highest possible standard both of production and quality in any branch of their individual manufacture.

A suggestion put forward by Mr. W. R. Barclay was to get, say, 100 firms agreeing to support the Bureau, each firm contributing, say, £50 a year. It would be managed by a committee of manufacturers who would have a technical director with three or four well-educated women, possibly University graduates, whose first duty it would be to house in their library all the information it was possible to obtain of a technical and scientific

character published in any part of the world. Correspondents would be appointed in every part of the world, who, for an honorarium, would furnish information of the kind they wanted and of interest to the trade. The technical director would get into touch with the work carried on by the various associations, technical schools and colleges, and this would be indexed and utilised.

The following resolution was carried unanimously:—"That this meeting is of opinion that it is desirable to establish an Information Bureau of scientific and industrial research on co-operative lines." The following were chosen as a committee to initiate the movement:—Messrs. J. W. Madeley, S. Evered, J. Earle, H. L. Heathcote, M. T. Murray, A. Tucker, and H. L. Reason.

Such an ambitious scheme as the one above outlined may not be suited to the constitution of the British Foundrymen's Association, but the basic idea is sound, and could be made the foundation of a very valuable movement. It is, of course, understood that under pressure of war conditions most of the leading members of the Association feel that they can spare little, if any, time for new activities; but, nevertheless, it is now that an information bureau would prove its value, and if properly organised it would not entail much work on the individual.

The Burning of Steel.

The phenomena of burning are so little understood by practical men that considerable interest attaches to a paper recently read at a meeting of the Cleveland Institution of Engineers, by Mr. W. H. Cathcart, on "The Burning of Steel." He expressed the opinion that the existing definitions of burning were somewhat ambiguous and confusing. Dr. Stead had proved conclusively that steel heated to above the point of incipient fusion might be restored if there was no intergranular oxidation present, and that there could be no restoration when the latter condition existed. It had been thought right to apply the term "burnt" to steel in either of those conditions, but in his opinion it would be in the interests of practical men if some distinction were made. He suggested that they should continue to apply the term to all steel heated above the point of incipient fusion, but that they should distinguish between the different kinds of burning. Broadly speaking, there were three different kinds or conditions of burnt steel:—(1) Burnt, meaning oxidised during heating; (2) oxidised during subjection to mechanical treatment while at a temperature above that of incipient fusion; and (3) heated to above the point of incipient fusion without oxidation. The oxidation to which he referred was intergranular oxidation, which could take place only when the metal was heated excessively high.

The speaker then proceeded to a consideration of what took place when a piece of steel was heated to an excessively high temperature. When the metal reached a red heat oxidation of the surface commenced, he explained, and at first the oxidation took the form of thin scales which peeled off from the surface, but presently the chemical action became so vigorous that a portion of the metal disappeared. Then the metal began to froth up or boil on the surface, the surface layers becoming so liquid that the oxygen from the air easily penetrated, forming bubbles or blisters which burst, leaving cracks or fissures, the walls of which were covered with films of oxide. This was true burning. A little reflection would show that after the steel had reached the point of incipient fusion the gradual heating would cause a corresponding lessening of cohesion in the bodies of the crystals, and that the stage at which the earlier small globules formed would coincide with the development of the small cracks or fissures if the metal were then subjected to mechanical treatment. Further, the steel would fly to pieces when the prolonged heating had caused excessive liquidation at the boundaries of the crystals, thereby reducing the force of cohesion to a minimum. Clearly, then, since there was a relatively large amount of carbon present in tool steel, and correspondingly of liquid surrounding the crystal at the point of incipient fusion, that was the reason why high-carbon steel was so much more easily burnt than mild steel.

Passing on to consider the different ways in which steel could be burnt, and to distinguish between burnt steel which could be restored and that which could not, the speaker remarked that, first, there was the case in which intergranular oxidation must take place in the outer envelopes. This frequently occurred while heating too rapidly in a smith's fire or when the flame impinged too sharply on the corners of the billets in the forge furnaces. If forged in this condition, steel would develop cracks on the surface, and would otherwise present a more or less roughly pitted appearance.

In conclusion Mr. Cathcart instanced two cases in which there was no intergranular oxidation during heating. Two pieces of steel were placed side by side in a furnace and were carefully heated to above the point of incipient fusion in a non-oxidising atmosphere. On removing one from the furnace and subjecting it to mechanical treatment, it would either develop cracks all over the edges or would break up completely. The cracks would permit the penetration of oxygen from the air, and again there was evidence of oxidation. What was the effect of allowing the companion piece of steel to cool down in the furnace to below the point of incipient fusion? They would find that it would work all right. The liquid burns, which were a direct cause of the cracking in the first piece, would have time to solidify again, and the steel would behave much the same as it would do if it were cooled down from the molten temperature for the first time in its life.

CHROME-STEEL FOR MAGNETS. — In the report of the German Imperial Physico-Technical Institute for 1916, it is stated that 37 alloy steels with varying contents of carbon and chromium have been experimented upon, and a substitute for tungsten steel has been found for making magnets, as all the available tungsten had been commandeered by the German Government for war purposes. Though not so good as are the best tungsten steels for the purpose, the chromium steel selected has given satisfactory results equal to those of the more common tungsten steels.

PREVENTION OF RUST.—A new rust-prevention process recommended for small machine parts is an application to the surface of the iron or steel of iron phosphates. After thorough cleaning, the articles are immersed in a bath containing ferric and ferrous phosphates, with a little manganese dioxide, and at boiling-water temperature they are left until hydrogen is no longer given off. The articles are then air-dried, when they may be treated with mineral oil, or painted, japanned, or otherwise finished. As the phosphate surface is attached chemically to the metal, no rust forms even in cracks in the paint.

Determining the Temperature of Liquid Steel.*

By Cosmo Johns, F.G.S., M.I.Mech.E.

It is a common experience that there is a marked thermal effect when liquid steel, flowing from the taphole of an acid open-hearth furnace, is succeeded by the first flush of slag, which must have been at approximately the same temperature as the liquid metal. Viewed through blue glass the slag is much brighter than the steel. The differences are considerable, and, as is well known, are due to the differences in emissivity of substances in different states and of various substances in the same state. If an observer is correctly placed, and watches a stream of liquid steel, reflections of light from the sun or an arc lamp can be seen, and it becomes evident that the surface of liquid steel possesses in a considerable degree the property of reflecting light. The liquid slag is less efficient in this respect. Now good reflectors are poor radiators, and the optical effect described confirms the thermal effect noticed with liquid steel and its slag. In the present writer's experience optical pyrometers using monochromatic light have proved most useful. Dr. Burgess† has recently published a most valuable account of investigations made in several American steelworks, as a result of which he was convinced that the results obtained were of a sufficient degree of accuracy to justify the adoption of similar methods in steelworks practice. The best confirmation of this conclusion is that the use of pyrometers to record the temperature of liquid steel and slags has been a part of the regular practice of one British works for nearly four years, while no doubt similar methods of control have been used in other places in this country.

Sources of Error and Accuracy Attained.—The use of measuring instruments, where a certain degree of accuracy is required, in industrial practice calls for special precautions, otherwise their introduction might cause greater difficulties and variations than the methods they were intended to supersede. The optical pyrometer using monochromatic light gives very consistent results, provided that certain conditions are observed. The liquid metal is best observed from a short distance, say not exceeding 12 feet, and at an angle as nearly constant as possible, for observations where the results are to be compared. Smoke and fumes absorb so much light that differences of as much as 40 deg. have been obtained between the windward and leeward side of the same stream; observations should therefore always be made from the clear side. There are slight, and not always constant, differences in the light emitted from various parts of the same stream; experience suggests that a field located in the centre of the side of the stream exposed to the observer gives the most consistent results on the whole. Reflected rays from extraneous sources of light must be rigorously excluded from the field.

It was found that a skilled observer could, with the aid of blue glass, from observations of the steel as it poured from the furnace into the ladle, estimate differences of possibly 10 deg. and certainly 15 deg. apparent temperature; while men watching the pouring of the steel from the ladle into the moulds, where the increased viscosity, due to decreased temperature, and other factors, rendered possible a greater precision in the estimate, could certainly distinguish differences of 10 deg. apparent temperature. Any pyrometer adopted must therefore be capable of giving consistent readings with greater precision than 10 deg. As a matter of fact, a trained observer can, with a suitable instrument, obtain readings with a variation of 2.5 deg. ± under very favourable conditions,‡ and this degree of accuracy is more than sufficient for effective control of the metallurgical processes employed. For each class of steel it is only necessary to determine—for the particular casting method employed—the "normal" temperature, when the steel is tapped from the furnace, which gives the best result. This "normal" may vary as the process employed is modified. The measurements involved are therefore divergencies from the particular "normal" adopted at the time, and as the range of variations in regular practice is small, no appreciable error is introduced by considering the differences in the pyrometer readings as temperature differences. The desirable temperature varies ± 10 deg. apparent from the normal, and a very high percentage of the casts do not appreciably exceed these limits. Temperature variations of ± 20 deg. apparent give rise to serious difficulties, and ± 15 deg. apparent can be considered to be the variation admitted in practice. These limits are for special steels; they are wider for ordinary commercial steels.

Temperature Distribution in the Furnace Hearth.—In view of the life of the refractory materials employed and of the fact that a layer of slag, composed of R.O. silicates, of some inches in thickness, intervenes between the bath of liquid steel and the flame employed for heating, the temperature distribution inside the hearth is of some interest. As all the heat received by the steel must pass through the covering layer of slag the surface of the bath must be at a much higher temperature than the steel itself, and the higher that surface temperature the more rapidly will the metallurgical operations be conducted. On the other hand, the properties of the refractory materials employed impose a temperature limit which cannot be exceeded without endangering the stability of the furnace structure. The readings tabulated herewith were taken immediately after tapping with the gas shut off from the furnace walls, and just before tapping with the gas momentarily shut off for the surface of the bath.

In order to correct the observed readings and convert them into degrees Centigrade it is necessary to assume a value for the emissivity of the interior of the walls of the furnace and for the surface of the slag. The difficulty is less in the

* Read, November 7, before the Faraday Society.

† Technologic Paper, No. 91, Bureau of Standards, Washington, 1917.

‡ This is, of course, exceptional, but with the best type of instrument readings can be reproduced with a variation of 3 deg. ± whenever the conditions are suitable. The routine readings can berepeated with a variation of something less than 5 deg. ±.

case of the slag than might be anticipated, for in the acid process it is invariably covered—at the time the steel is ready for tapping—by a peroxidised layer. Burgess assumed 0.53 for liquid oxide of iron; in this Paper an emissivity of 0.50 is assumed for the slag surface. The slag below this peroxidised layer, which is what is observed flowing from the taphole after tapping, possesses its own emissivity, which can be determined with some degree of accuracy by comparing the apparent temperature of the last steel observed to leave the taphole and that of the first slag to appear. These must have formed contiguous layers in the furnace, and be nearly at the same temperature. The assumption of an emissivity of 0.40 for the liquid steel enables that of the slag to be calculated. As will be pointed out later, there is an appreciable temperature gradient in both steel and slag when in the furnace, and a comparison of the mean temperatures might import a considerable error. Seasoned silica bricks, which form the surface of the interior of the hearth, contain a considerable quantity of magnetic oxide of iron, and the face of the brick may be regarded as saturated with the molten oxide, with cristobalite grains projecting through the oxide. Its emissivity is therefore a doubtful value; an assumption that it is nearly the same as the molten oxide itself, though probably involving an error, can be corrected when a better value has been experimentally* determined. It is noteworthy that a very pure silica sand, 99.45 SiO_2, can occasionally be melted on the surface of the bath into a viscous mass of fused silica, that wraps itself round the tool employed to withdraw it from the furnace. It is not often that the temperature necessary to accomplish this can be achieved. It is very probable that a temperature nearer 1,850 deg. C. than 1,800 deg. C. is necessary.

Temperature Gradient in the Bath.—From Table I. an average temperature for the surface of the bath may be assumed as 1,625 deg. apparent =1,753 C., in which case an assumption of 1,470 deg. apparent=1,615 deg. C. for the average temperature of the steel would be in accordance with experience. This indicates a pronounced temperature gradient in the bath, as might be anticipated from the mode of heating employed. The character of the gradient can be determined by observations, at short intervals, of the stream first of steel and then of slag as it issues from the taphole into the launder. After the first flush of steel has passed, and the smoke cleared away, it is found that a sharp rise takes place between the first two observations, and that the rise is more gradual afterwards until the first streaks of slag appear, when another sharp rise occurs. With a bath 16 in. deep a total rise in apparent temperature of 15 deg., extending over a tapping period of five minutes, is the usual experience. When the full stream of slag (with a probable thickness of 4 in.) appears, a sharp rise at the rate of 15 deg. in two minutes occurs. The extreme ends of the gradient remain unexplored. Typical readings of a flow of the duration stated would be:—

	Apparent temperature near taphole.	Time, a.m.
Clear stream of steel	1465	10.31
,, ,, ...	1470	10.32
,, ,, ...	1470	10.33
,, ,, ...	1475	10.34
,, ,, ...	1475	10.35
Last steel	1480	10.36
Clear stream of slag	1495	10.37
,, ,, ...	1505	10.38
Last slag .. ,, ...	1510	10.39

The difference in the readings, for apparent temperature, of the last appearance of a clear stream of steel and the first full stream of slag varies with the time interval between the readings. For the same cost the apparent temperature at the end of the launder at 10.34½ was 1,470 deg. apparent, while the reading for the slag at the same poiut at 10.39½ was 1,510 deg. apparent. The slag temperature obtained at the end of the flow will represent a layer that was not far from the surface of the bath before tapping. Some difficulty has been experienced in determining the emissivity of these acid slags. Burgess found 0.65 for his dark slags, but this would give values much too low for the acid slags discussed in this Paper. For the present it will be best to record the facts as observed and postpone a discussion until further investigations have been made. A difference in apparent temperature of 40 deg. at the end of the launder is the average for a large number of casts. With this difference at the point where the observations were made the slag would represent the higher and thus very hot layers, while the steel temperature recorded would be an average.

Variations in the Stream.—As the stream that leaves the end of the launder is on the whole the

TABLE I.

	Position.		Pyrometer readings with temperatures corrected for emissivity. λ=0.70 μ. ϵ=0.50.							
ϵ=0.56.	Centre of hearth ..	Apparent temperature ..	1600	1590	1615	1620	1625	1615	1610	1625
		Corrected temperature C.	1704	1693	1721	1727	1732	1721	1715	1732
	Centre of roof ..	Apparent temperature ..	1585	1600	1590	1600	1590	1575	1560	1575
		Corrected temperature C.	1687	1704	1693	1704	1694	1676	1660	1676
	Tapping side wall ..	Apparent temperature ..	1625	1625	1650	1635	1660	1650	1640	1660
		Corrected temperature C.	1732	1732	1760	1743	1771	1760	1749	1771
	Port block where gas last entered ..	Apparent temperature ..	1645	1640	1655	1650	1665	1665	1650	1670
		Corrected temperature C.	1755	1749	1766	1760	1777	1766	1760	1783
	Exit port block ..	Apparent temperature ..	1635	1635	1640	1650	1625	1640	1630	1645
		Corrected temperature C.	1743	1743	1749	1760	1732	1749	1738	1755
ϵ=0.50.	Surface of bath before tapping	Apparent temperature ..	1625	1595	1635	1645	1660	1635	1640	1665
		Corrected temperature C.	1754	1719	1766	1777	1794	1766	1771	1800

* When a patch of new silica bricks in a "seasoned" wall is compared with the adjoining old bricks a marked difference in apparent temperature, about 90 deg., can be observed. If the emissivity of new silica bricks at about 1650 deg. could be determined, the other emissivities could be calculated.

most convenient for observation, it was necessary to determine whether all parts of the stream gave the same readings, and whether distance was a factor to be considered. Readings from a considerable distance were nearly always low owing to the difficulty in filling the field, and the effect of smoke and vapour, and afforded no compensating advantage. The stream itself gives varying readings both for slag and steel even when a full field is obtained, and here again it is perhaps better to state the facts and postpone a discussion of the probable reasons. The centre of the exposed side of the stream gives a lower reading than the bottom when observed from the side, at an angle of about 45 deg. with the axis of the launder, both for slag and steel, except when the deoxidisers are added in the ladle instead of the furnace, when the top of the exposed side often gives higher readings than the middle and bottom. The steels that have not been de-oxidised before entering the ladle often have a film of oxide on the upper surface which has a higher emissivity. On the whole, having regard to the fact that the purpose for which the routine observations were made was to determine divergences from a normal, the centre of the exposed side of the stream nearest the end of the launder gave the best results and was adopted as a standard. A full stream of slag nearly always gave higher readings at the bottom edge of the exposed side than either middle or top, the exceptions being when bottom and middle were the same. Table II. is a record of consecutive costs.

TABLE II.

		Position.	Pyrometer readings uncorrected. λ=0.70 μ.									
Observations of stream at end of launder.	Steel	Top	1465	1470	1470	1460	1475	1470	1470	1475*	1460	1480*
		Middle	1475	1475	1470	1460	1485	1475	1475	1470	1465	1475
		Bottom	1480	1480	1475	1465	1490	1480	1480	1475	1470	1475
	Slag	Top	1515	1515	1510	1505	1515	1515	1510	1510	1500	1515
		Middle	1515	1520	1515	1505	1515	1515	1515	1515	1505	1515
		Bottom	1520	1525	1515	1510	1520	1520	1515	1515	1505	1520

* Deoxidised in ladle.

Thermal Losses.—There is a sharp drop in the readings when the clean surface of the steel in the ladle is compared with the stream flowing from the taphole. For an accurate determination of this difference it is necessary to recognise the gradual rise in the stream that issues from the taphole, for if the comparison be made between the ladle reading and that of the steel that issues last from the taphole the difference will be greater than if made with an earlier reading. The most consistent results will be obtained if the comparison be made with the standard readings at the launder end. The mean of a large number of observations was 30 deg. apparent. This is the stage at which the greatest thermal loss occurs, and affords the most convenient datum point from which the subsequent losses can be calculated The turbulence within the ladle is always causing the contents to be well mixed by removing the cooling layers from the bottom and walls of the ladle. The loss though considerable is not more than would be expected. Once the liquid steel has been covered by its protecting layer of slag the thermal losses rapidly diminish. The most accurate way to determine the losses during the casting operations is to observe a plane surface of the liquid steel when possible, or streams whose exposed surface has a considerable radius.

Observations of a broad stream of steel falling over the open end of a spout, placed between ladle nozzle and mould, give very consistent readings if a skimmer be used to prevent any oxide floating into the field of the pyrometer. If the observations are made on the surface of liquid steel in a small trough, feeding two or more moulds, the conditions are more complex. The stream from the ladle nozzle appears dark when compared with the plane surface of steel in the trough as background, and the plane surface apparent temperature is higher than that of the steel falling into it. If the plane surface be carefully explored it is found that the clean area near the falling stream is the same apparent temperature as the stream itself, as it should be in such a small trough, but as the field under view is shifted along the surface towards the end of the trough the apparent temperature steadily rises

TABLE III. *Pyrometer Readings Uncorrected.* λ=0.70μ.

Group of moulds.	Time when observations on each group commenced.	Apparent temperature of steel from ladle nozzle.	Apparent temperature showing effect of oxide film (steel, clean surface ε=0.40.) (oxide film ε=0.53.)					
			Surface of steel in trough.			Apparent temperature of steel from trough nozzle	Surface of steel in ingot moulds.	
			Centre near stream from ladle.	Intermediate.	Oxide film near end.		Centre.	Side.
First	6.20	1400	1395	1425	1440	1380	—	—
	6.25	1398	1400	1435	1440	1395	1390	1425
Second	6.31	1396	1390	1430	1440	1390	1390	1425
Third	6.36	1394	1395	1430	1435	1390	1390	1425
Fourth	6.42	1392	1395	1430	1435	1388	1385	1420
Fifth	6.48	1390	1390	1425	1435	1386	1385	1420

owing to the growth of a surface film with higher emissivity, until near the end an oxide layer is reached with a much higher apparent temperature. The apparent temperatures tabulated in Table III. illustrate this very well. The ladle observations from the same cast are given in Table IV.

TABLE IV.

Time.	Temperature.		Remarks.
	Apparent.	Corrected.	
	Deg.	Deg.	
6-10	1450	1502	
6-11	1460		ϵ=0.40
6-12	1460	1602	λ=0.70 μ
6-13	1460		

The Open-hearth Furnace as Pyrometer.—Surprise is sometimes expressed that workmen can control their furnaces within the narrow temperature limits demanded by good practice in open-hearth steel manufacture. It so happens that the furnace is a by no means inefficient pyrometer. The long flame reaching nearly, if not quite, the length of the furnace, when using producer gas of regular composition, is approximately of constant temperature and hotter than the walls and end blocks of the furnace. When the furnace temperature rises so that the flame cannot be distinguished from its background, the melting range of silica bricks has been reached, and if the temperature be maintained their fusion would result. The flame is therefore shortened until the temperature of the bricks becomes reduced and the flame can be distinguished. The control is therefore effected by noting the difference in apparent temperature of the flame and the exposed surface of the furnace walls and end blocks.

Conclusions.—In the manufacture of acid open-hearth steel a trained observer using a correct type of pyrometer can obtain readings of sufficient accuracy, when the necessary precautions are taken, to secure effective control of the process. Under the most favourable conditions the apparent temperature can be read to within 3 deg. $\pm$ and under normal conditions to less than 5 deg. $\pm$. As divergences from a determined "normal" are sufficient for this control the pyrometer's readings can be used to determine temperature differences without importing any serious error.

The most suitable instrument is an optical pyrometer using monochromatic light 0.65μ, which it is suggested should be adopted as a standard. It should have a scale that can be read, under industrial conditions, to 2 deg.

The thermal losses are small once the steel has been covered with slag in the ladle after the first five minutes.

The most consistent results are obtained when observing plane surfaces or curved ones with a large radius, provided that they are not contaminated with molten iron oxide.

Observations on clean surfaces of liquid steel can only be made when the steel is in motion. Any determination of apparent temperature will therefore only refer to the particular surface that was observed at the instant the reading was made. All such moving surfaces are either rising or falling in temperature, so that the relative time at which the observation was made is an important factor when comparable results are desired.

Official Pyrometer Corrections to add to Pyrometer Readings for Emissivity.
Calculated from the formula—

$$\log 10_{\epsilon} = \frac{C \log E}{\lambda}\left(\frac{1}{T}-\frac{1}{S}\right)^{*}$$

Wave-length=0.70μ; ϵ=emissivity; C=constant, 14,500; E=Napierian base, *i.e.*, log E=0.4343; T=true temperature absolute; S=observed temperature absolute.

Corrections to add to Pyrometer at Various Temperatures and Emissivities. μ 0.70. *Pyrometer using Red Light.* (S.F.B.)

Emissivity.	Temperature observed.						
	1350 deg.	1400 deg.	1450 deg.	1500 deg.	1550 deg.	1600 deg.	1650 deg.
0.40	125	134	142	151	160	169	179
0.50	93	99	105	112	118	125	132
0.60	68	72	77	81	86	90	95
0.65	57	60	64	68	72	76	80

* The formula is taken from Technologic Paper, No. 91, Bureau of Standards.

A HUGE CASTING ON THE RAILWAY.—What is stated to be the largest metal casting ever produced in this country was recently conveyed from Mr. C. W. Taylor's North-Eastern Foundry, South Shields, to Sir W. G. Armstrong, Whitworth & Company, Elswick Works, Newcastle-on-Tyne. The weight of the casting was calculated to be 85 to 90 tons, and was the largest item of an order for cast-iron blocks, which also include two 60 tons and one 71 tons. Three North-Eastern Railway 40-ton flat wagons were selected to carry the load, which rested on the centre wagon, and by means of timber and steel beams well braced together, a portion of the weight was transferred from the centre wagon to each of the two outside carrying wagons. Two additional 20-ton trollies were required to complete the arrangement, one at each end, and acted as runner wagons for the ends of the levers, from which balance weights were suspended. The arrangement proved entirely satisfactory, and an average speed of 5 m.p.h. was made.

NICKEL STEEL.—Mr. S. W. Parker, in a recent number of "The Iron Age," describes the results of experiments made in the testing department of the Bethlehem Steel Company at Steelton, Pa., in order to determine the best annealing temperatures for two grades of 3.50 per cent. nickel steel, generally used for forgings. The test bars were forged down to 1 in. square by 6 ins. long from two 4 x 4-in. billets of different grades. The minimum hardness and tensile strength were obtained by annealing at between 1,250 and 1,350 deg. Fahr., at which temperatures the structure had only started to break up and refine. The property most affected by annealing is the elastic limit. This was increased from 41,000 lbs. in the unannealed bar to 50,000 lbs. per square in. in the bar annealed to 1,400 deg. Fahr., in which the grain was the finest in the series. This increase in elastic limit by refinement of grain plays an important part in annealing forgings, especially when high elastic limits together with good ductility are specified. The best combination of physical properties in the case of 3.50 per cent. nickel steel of 0.22 per cent. carbon is obtained by annealing at a temperature ranging between 1,400 and 1,450 deg. Fahr. A similar series of tests on nickel steel of 0.41 per cent. carbon indicated a general similarity in the properties. For this steel the best combination of physical properties is obtained by annealing at between 1,350 and 1,450 deg. Fahr., the minimum temperature being lower than in the case of the 0.22 per cent. carbon steel.

Relationship Between Drawing-Office, Pattern-Shop and Foundry.*

By J. Shaw.

The question of design is intimately connected with various foundry problems, and has been constantly referred to in many of the papers read before this Association. Very few draughtsmen appreciate the many difficulties with which the foundryman has to contend. It is essential that the designer keep in mind the cooling processes through which the casting must pass, and the effect which will be produced upon any member if it is cooled faster or slower than other parts of the casting. I believe there are in actual work many castings of doubtful reliability, owing to internal strains and lack of harmony in their constructive elements. The usual drawing-office

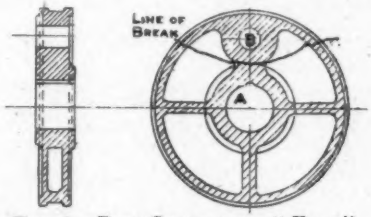


FIG. 1.—DISC CRANK THAT "FLED" IN TRANSIT.

assumption, that sections of castings are regarded as beams in tension or compression as the case may be, and their strengths calculated accordingly, takes no note of the casting passing from the molten to the cold condition, and ignores the stresses set up by unequal contractions, so that some members that were expected to be in tension are actually in compression and vice versa. There are three points to which designers should give their attention.

(1) Faulty design, which may be sub-divided into designs that cause undue stresses through cooling strains, and others that cause unsound places in important points, through excess metal.

(2) The attempt to save joints by asking for castings that are both expensive and risky to make, out of all proportion to the saving effected.

(3) Simplicity of design from the moulding standpoint, and needless alteration of design in small details that causes new tackle to be made, and adds to the cost of production.

Taking the points in sequence—I know it is not always possible to avoid quick changes from thin to thick sections, and it is here the knowledge of the foundryman must come to the rescue. But while it is possible to meet these conditions by the use of denseners, baring, alteration of position of runners, etc., engineering design is at its best when its shapes are at once suitable for its intended purpose, and easily and cheaply produced. That faults of this sort are common at present we all know, and perhaps three that recently came before me will best illustrate this. I was asked a few weeks ago to quote for a number of marine condensers with the cylinder columns cast to them. To quote Mr. Mayer, this is "perhaps one of the most fruitful sources of breakdown at sea," and which I thought had been done away with; yet it cropped up again in what I presume was the design for a standard boat.

Another example is a baffle plate about 3 ft. diameter, the outer edges 4 in. wide by 1 in. thick, the perforated portion being ½ in. thick. Several "fled" in the machine-shop, but the difficulty was overcome by running in the centre, and baring the outer edge both top and bottom. In this case there was no reason why the middle of the plate should not have been thicker and saved the cooling strains. The third example, while the design was not so bad, illustrates the strains set up that do not always show at once. A large disc crank (Fig. 1) was cast in the ordinary manner, and after lying about for a few days was shipped off to its destination. It arrived there short of a piece which weighed nearly two tons, and which was found by the platelayers on the line, the internal strains having been so great that the piece jumped clear of the wagon.

That design is responsible for many leaky and porous castings is common knowledge, and the use of large fillets and brackets is often a source of weakness rather than strength. The effect of these faults is exaggerated in steel. It may be taken for granted that where there is a thick section, that portion of metal will be the last to set, and will act as a feeder to the other parts, leaving a void, or at least a spongy place that denseners do not always overcome. Often a little modification in design would alter this. Practical illustration will best show. We made a number of 8-in. bend

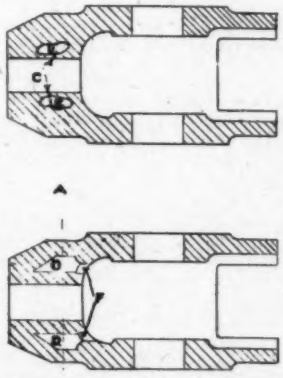


FIG. 2.—CROSSHEAD, SHOWING SPONGY PLACE, AND ALTERATION.

pipes, which evidently fitted up to 10-in. pipes at one end. The diameter of the flange was simply increased, and a large fillet put in nearly to the edge of the bolt hole. There is little doubt the metal was not solid there, and it was only after rusting up that they stood the water test, yet we were not allowed to alter it.

Fig. 2 shows a crosshead casting that gave trouble, the portion B often being spongy when the

* Read before the Birmingham Branch of the British Foundrymen's Association, October 27, 1917—Mr. A. Harley in the chair.

thread was cut for the piston-rod at C. The remedy was found by coring out, as at D in the lower sketch.

Another case was the middle portion of a cylinder of a plunger pump. In this style of pump, two plungers work in opposite ends of the barrel, and there is a partition cast in the centre. This thick partition caused a porous place which the acid water from the mine quickly ate away, necessitating the renewal of the cylinder every few weeks. Making the partition thinner and strengthening with thin ribs did away with the trouble.

A rather remarkable instance of the effect of the crystallisation of metals was given by Gilmour, as shown in the following illustsation. Fig. 3 is the section of a slide valve cylinder, through the centre of the exhaust port. The design looks all right at first sight, but in practice and theory it is wrong, as the heavy body of metal at *AA* is longer in cooling than at each side, and the crystals are formed in opposite directions to each other, causing a weak plane at this point. After the engines had been running for some time, quite a large number cracked here and led to legal controversy regarding the quality of the metal. With the quick recurrence of the fault, the design was altered, as shown, *BB* in the right-hand sketch, and no further trouble was experienced.

Turning to the second point; while, without doubt, there are advantages in having as few

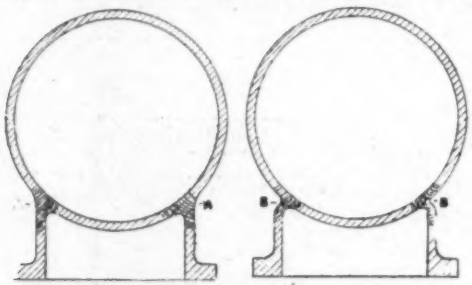


FIG. 3.—CRYSTALLISATION OF METAL IN CYLINDER.

joints in a machine as possible, to lessen fitting costs, and also to lessen the risks from vibration, etc., often the added costs and risk in the foundry are out of all proportion to those gained. Recently a set of steam pipes was urgently wanted for a munition works. Some of the bends were about 8 ft. long and 4 ft. on the other leg, and only 10 in. diameter. These not only would have had to be made in a 24-in. box, but increased the risk of the core lifting between the chaplets, and, as is known, there are no means of calipering a long bend of this description. Several of the remaining pipes had long double bends, costing about £5 per ton for patterns alone. These were quite long enough to have been cut in two and made as two ordinary angle bends. As a quick delivery could not be promised as received, the position of joints in the whole range was altered, thus proving there was no real reason for these extreme sizes.

Reverting to the condenser above-mentioned, this is what Mr. Mayer calls "the greedy design, where a part of an engine is made to answer a double purpose." A casting we made a number off with quite satisfactory results, was altered to have the branches cast on, instead of studding short bends to their position. This made a simple mould into quite a complicated one, necessitating either drawback or blocking out for cores, either way doubling the cost and risk. The metal was only ½ in. thick, and there was no means of seeing if the long branch core crushed or knocked a piece off the mould in lowering in. Whether the alteration was worth it is an open question; certainly it made a simple job a risky one.

Coming to the third point, I know the drawing staff are often compelled to make slight alterations to meet the wishes of the consulting engineer, but if both realised, to take a recent instance, that altering the position of the feet and slightly increasing the size on the same size condenser, increased the moulding price by £1 per ton in tackle alone, the question would receive more consideration. There are many cases where a little more thought in the drawing-office would simplify the design with regard to both pattern and moulding without sacrificing either its usefulness or strength.

The foreman pattern-maker and the foreman moulder are each apt to want to do things in a way that may not be for the best interests of the other party, nor, which is of far more importance, for the best interests of the firm. It is quite natural the pattern-maker should wish to make a pattern in such a way as to reflect credit on himself, or to save money for the department he manages. This being so, he is apt to insist on certain things against the wishes of the moulder. This friction is fatal to maximum production. We may not eliminate all friction, but it may be materially reduced by a judicious exercise of reasonableness and common sense. Both men should meet on a common plane; one should not expect too much from the other. The moulder should not expect the pattern-maker to put several unnecessary hours' work upon a pattern, when he can accomplish the same result in much less time; neither should the pattern-maker slight his part of the work, which may be done in a multitude of ways, thereby entailing extra work, of a more or less difficult character, on the part of the moulder, sometimes resulting in an inferior casting, which reflects no credit on either.

The chief consideration should be as to how the pattern may be made so as to produce the casting at the least cost, everything being taken into consideration. This may be an entirely different question from any of the following:—How can it be made to last the longest? How can it be made so it will not warp out of shape? How can it be most cheaply made? How can it be made to give the truest castings? Fulfilling the requirements of the first question may also be the best for some of the conditions the other questions suggest, but that is a matter that will adjust itself if the first governs the policy.

The cost of pattern-maker's work is part of the cost of the casting, just as much as the cost of the pig-iron, so if a nice mahogany pattern will be best, it should be made, sparing neither materials nor labour. A chunk of wood and a few minutes' work with a band saw may be good enough for the next casting, and a new one may have to be made every day.

It has been frequently stated in our meetings that the moulder should have the last say as to the way a pattern should be jointed for moulding, etc., and with this dictum I am quite in accord, if the moulder has that knowledge of mechanical drawing to see from a complicated blue-print how he wishes to mould the job, where to joint it, and

where to put draft, etc. I have a few very good moulders, but not one of them can give me any assistance, either as to method of making or time, from seeing a complicated drawing. Every moulder with any ambition should take a course in machine drawing, or, perhaps, better still, take up the problems in solid geometry as far as "Sections by oblique planes." He will find the latter quite as interesting as a game of chess, and few drawings would puzzle him afterwards. I know these things demand sacrifice, but to my mind it is of more importance than a course in metallurgy. The time to say how a pattern shall be moulded and jointed is not after it has been made, but before it is started.

Fig. 4 shows a case of extra cost to pattern-shop

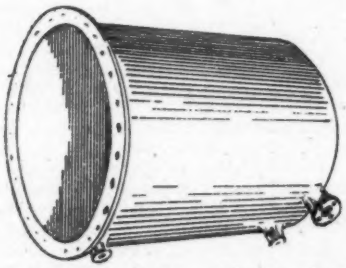


FIG. 4.—POTS CAST IN GREEN SAND.

and little saving in the foundry. It was intended to make these pots in loam, but every loam moulder and stove was fast for three months, so the work was done in green sand to get these castings out with the rest of the order. The pots were 3 ft. diameter and 4 ft. deep, with metal ¾ in. thick. The thickness of metal precluded building the pattern in wood, so it was carefully struck up in loam, giving ½ in. taper in the length, that is, the thickness at the flange end was made 11-16 in. and tapered to 13-16 in. at the top. A shoulder was cast to receive the flange. With careful fettling and varnishing we obtained very satisfactory results. It is obvious the chief difficulty lay in making the green-sand core to stand up against the grip of the metal, and yet vent freely enough not to "flutter" when the metal covered the bottom of the pan, which was cast with the bottom upwards. The procedure was as follows:—

Below the shallow drag a good ash bed was made and carried outside the box part. The loose flange was next levelled with the edge of the box to receive the iron pattern. To help the vent to get away easily, a perforated pipe (an old corebar about 14 in. diameter by 3 ft. long) was set up in the centre of the flange, the lower end going into the ash bed. The iron pattern was lowered into the flange. To give the core stability, stakes about 1 in. diameter by 4 ft. long were driven down, and outside these ½-in. hoops at various intervals as the ramming up of the core proceeded. About 6 in. from the top of the core, the sand was mixed with a certain proportion of sharp sand to help the vent from the covered end. The outer box was in two pieces, a deep piece (part of an old pipe pit box) and a shallow piece about 11 in., which we cast to make up the correct depth. The latter had an internal flange to carry the sand. We had an experience with these castings that illustrates how little things upset a moulder's calculations. The casting was run with two 1½ in. diameter gits, with sprays cut into the bottom flange. The first casting was all right. The second blew badly, and it was concluded the outlet from the core did not take the air off quickly enough, as it was only when the mould was full there was any sign of a "flutter." The outlet was again increased, and the third casting was quite right. The fourth was again bad in the same way as the second. The moulder was quite discouraged, so some time was spent going over each operation. It was noticed that the flange of the branch, which was the highest point in the mould, was solid, but that both gits were blown for some inches below the casting; but even with this information I doubt if anyone can just put their finger on the cause of the failure. The gits ran from the top to the bottom of the mould. To stop the pressure of metal bursting these, cups were rammed up round the git as the ramming up proceeded. Our usual practice is to take the short pieces cut off the vertical pipes that give solidity to these castings, pieces anything up to 6 in. long. These were used in the shallow bottom ring, but when the deep piece of the box was put on, owing to the difficulty in ramming and fixing these short pieces, a long piece of 4-in. pipe was put round each runner. The whole of the trouble came from this source, as the gases could not get away, and once the casting was up the metal in the down gits began to kick, and drained some of the metal from the casting. The reason the first and third were right I can only think was due to light ramming in the 4-in. pipe

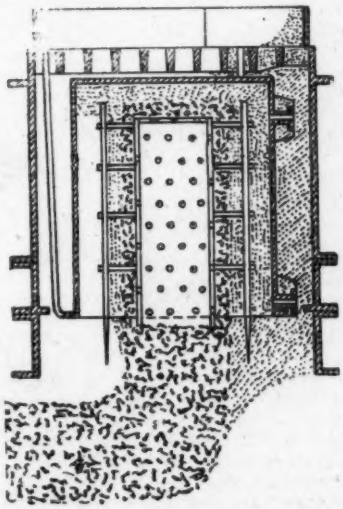


FIG. 5.—MOULDING OF POTS IN GREEN SAND.

round the git, and the air forcing itself out without creating a disturbance.

In the case of a similar casting the core was bricked up on loam, but was cast the same way, bottom up. When the casting was nearly full the vent was lighted, and, of course, the explosive mixture formed inside the core burst the core. Either the core should have been filled with hay or shavings, or the vent pipes carried further away, so that no spark could fire it. The latter was done in the case mentioned.

Discussion.

Mr. Harley said that one important point was the number of castings that had to be made from one pattern. Where the work was largely repetition work his firm spared no expense on the patterns, stripping plates and core boxes, because they felt that all the money that could be spent in that direction was repaid by advantageous production. They believed in bringing the cost of the work to the lowest possible point, and that from this point of view it was worth while to spent money upon the patterns. Founders who were doing outside work no doubt often had patterns sent to them in very bad condition, and perhaps not made properly, and were in a rather difficult position; they could not lay down the law to the customer, but had to put up with some things for fear of losing the job. Still, he thought foundrymen should make a strong stand with regard to patterns, for there was no satisfaction in trying to mould from badly made and badly designed patterns. At his works they had a great advantage in having the designs submitted to the foundry department before the patterns were made. They had an opportunity of consulting with the designer, and any suggestions that they made which did not interfere vitally with the design were accepted. They did not take so much trouble when the work was in the experimental stage, but the moment a job was standardised every care was taken to adapt the design as far as possible to foundry conditions. He thought that the foundry management should be entirely responsible for patterns for standard work.

Mr. F. J. Cook said it was wrong that men were allowed to be all their lives designing things to be made in a material of which they knew nothing. No doubt if they could get draughtsmen to take some interest in such matters as the crystallisation of cast iron they would get very much better results. Mr. Shaw had drawn attention to two or three things bearing on this question of crystallisation. He (Mr. Cook) sketched one or two cases which were very apparent to the foundryman but were very often missed by draughtsmen. Ribs, as usually designed, were invariably a form of weakness. A rib very often weakened the casting by an amount greater than the additional strength it was introduced to give. By cutting out in the design some of the solid part so as to make a flying buttress rib of it, the weakening of the casting could be avoided. In the case of a stuffing box, say in a cylinder cover, the designer would place a number of ribs all round for the purpose of strengthening the casting. But if these were made solid the result would be that they would have the ribs pulling in different directions owing to the enormous mass of metal. This could be avoided by making the ribs open. He quite agreed with the Chairman that the patterns should be made to agree with the conditions laid down by the foundry. That, however, as Mr. Shaw had told them, involved another condition, namely, that they must be quite sure that the foundryman was in the position to state properly what he wanted. His own view was that the pattern room should be regarded as having the same relation to the foundry as the tool room had to the engineering workshop. Manufacturers would give any amount of time and trouble and expense to maintaining an up-to-date high-class tool room, whilst they grudged any time or money spent on patterns.

Mr. J. G. Donson said that in regard to making large castings in dry sand from patterns, they were made in strong sand, which was practically loam; but such as the one Mr. Shaw had mentioned would, he thought, be safer and less costly if swept up in loam. Since the advent of rubber tyres, and for the last five years, he had been making motor tyre moulds in loam, and nearly every mould different, so that the cost of patterns would be heavy. These moulds weighed from 6 to 14 cwts. per set of three castings. They were made in loam at practically less than the cost of patterns. Moreover, these moulds had to be turned and polished and engraved, and when they were made in loam and thoroughly dried they gave what was required with more certainty than could be obtained with sand moulds.

Mr. E. N. Wright said the lecture would be valuable if it did nothing more than lead responsible men in the different departments of their works to drop their individual fads sometimes and seek to work together for the good of their concern, and to adopt whatever method would be of the greatest profit to their firm. He himself had often seen cases where two or more departments, being distinct, each had considered the work from its own point of view instead of bringing their individual knowledge into the common stock with a view to adopting a method which would be most suitable for successful and economical production. The points of view of men engaged on what might be called jobbing work and of those engaged on repetition work were, of course, quite different, and very often, no doubt, the pattern which could be made at the least expense was the most suitable where only a few castings had to be made from it.

Mr. R. Buchanan agreed with Mr. Wright that whilst the departmentalising of large works was a necessary thing it brought in its train what might be called departmental jealousies. When the head of a department knew that he was going to be faced at the end of the year with certain figures, he strove for all he was worth to keep within those figures, whereas the man who was sure of himself took a larger view and kept in mind the ultimate benefit of his firm.

Mr. Charles B. Roe said that a good deal of the fault in regard to co-operation was due to management. The designer was placed in the position of a staff man and considered himself far superior to anybody in the works. It took just as much brains to make the patterns after one had got the drawing as to make the drawing, and it took just as much brains and skill to make the casting after one had got the pattern. His firm made a practice of having the heads of all the departments together once a month for consultation. An opportunity was thus afforded for the heads of the founding department to explain to the designer what could be done and what could not.

Mr. D. Cresswell said he had noticed a great number of draughtsmen who never went into the foundry or the pattern shop. This was a fruitful source of faulty design so far as pattern shop and foundry were concerned. Where a section was set out which would be detrimental to the casting this should be pointed out to the draughtsman, who in most cases could alter his design to suit the foundry requirements.

Mr. Shaw, in reply, said that he was quite in agreement with Mr. Harley that under such conditions as Mr. Harley was accustomed to the cost of

patterns was of little moment. But where only one casting was required the cost was a vital matter. He had to thank Mr. Cook for his notes and sketches on the effect of crystallisation. Several speakers had laid stress on the need for co-operation between the departments and meetings to discuss best methods. That was quite right if each member were qualified to give satisfactory reasons for an alteration, and could see exactly how to make the casting from the drawing submitted. For this reason, he had emphasised the importance of moulders and patternmakers making a study of machine drawing. The former should study the subject not for reading the drawing but in order to be able to locate any weak spots in construction which, from their experience with castings, they knew would be points of weakness if the casting were made as set out in the drawing.

The Foreman Patternmaker.

By James Edgar.

Efficient foremen patternmakers are always difficult to get, and troubles are like mushrooms in the first days after the craftsman's promotion. There are qualifications necessary for all foremen, such as tact, firmness, and an extensive practical experience, but there are besides special qualifications which the aspiring patternmaker should have.

It is true of the benchman, but it is more true of the foreman, that he should be a capable draughtsman, have a good knowledge of moulding, and know the limitations of the various machines which finish the castings. It is not sufficient for him to be able to read a drawing; he ought, if necessary, to be able to make sketches from old castings, and a familiarity with isometric projection is invaluable. Isometric projection is very simple, and should be more used in the pattern-shop than it is. All workmen are not clever, and it is so much simpler to make an isometric sketch, or even a picture view, than to explain a difficult job. It helps the unimaginative craftsman to visualise the finished work for himself, and a great deal of time is wasted by the average man trying to see the pattern as it will be when finished. This power of visualising things is also a great help when considering the moulding of a pattern. It is so much easier to think in the concrete than the abstract, and if the foundry conditions are ever present in one's mind the construction of the pattern is simplified. It is a pity that pattern-shop apprentices are not afforded the chance of acquiring first-hand practical knowledge of moulding, so that they could get in a year or two what usually takes many years of close observation.

Good machines in the pattern-shop should be insisted upon. Managers often seem to think, probably because patternmaking is primarily a hand craft, that machines in the pattern-shop are not very important. The truth is, that an initial expenditure on machinery is soon repaid. As important as having the machinery is the economical use of it. A foreman can see a great deal as he walks about the shop, and if the men and boys know that he has a jealous regard for the machines, carefulness for them will become a habit. The breaking of bandsaws, the cutting of nails, the "lipping" of planing-machine knives are nearly always avoidable. Much timber is wasted at the saws, and especially at the bandsaw, owing to bad marking off, and few foremen, even when passing by, pay any attention to wasted timber.

It is wise for a foreman to discuss work with men when he gives out the drawings. If he tells a man abruptly the way he wants the job constructed, or pooh-poohs any suggestions that may be offered, he lessens the craftsman's interest, and in all probability increases the cost of the work. It is indeed better to let the man have his own way if there is little difference between two methods. With many men their chief interest in their work is thinking out the best way of doing it, and if their initiative does not get scope, they become, to use a slang term, "fed up." Some foremen meanly allow the patternmaker to get a good deal done before offering any opinion, then condemn the work, not on its merits or demerits, but simply because they were not consulted.

Checking is a very important part of the foreman's duties. There is a tendency when a foreman forms a high opinion of certain of his men to allow their work to pass almost unmeasured. This is decidedly foolish. The most careful makes mistakes, and frequently a job may be made to the drawing, but the drawing may be incorrect, and the craftsman may not have noticed it. The dimensions on one view may conflict with the dimensions on another, or the draughtsman may have neglected to leave tool clearance for the machine. Whatever method of checking the foreman adopts should be used for every job that goes to the foundry. It is also better to have patterns returned to the shop for alterations rather than leave it to the moulders, who have not a drawing, to alter them.

It is not right for a foreman to tell boys exactly how to proceed with a new job; nor should he encourage the men to do so. A lad who has done no thinking during his apprenticeship is a pitiable spectacle when he becomes a journeyman. He ought to be watched closely and advised, but only after he has thought for himself. A great misfortune for the boys in many pattern-shops is that they are allowed to use the machines almost from the day they start their apprenticeship. Foremen anxious for results from the beginning do not allow them to use their tools as much as they ought to do. It should be remembered that a lad who does not use the machines during the first few years of his apprenticeship is a greater asset in the long run. It may be possible to do very simple jobs almost entirely at the machines, but the machines are not indispensable, and there is much work which they cannot do.

EFFECT OF PICKLING ON STRENGTH OF STEEL.—Brittleness of steel springs resulting from acid pickling and electro-plating is a well-known phenomenon. Mr. John Coulson, who is physical chemist of the Westinghouse Research Laboratory at East Pittsburgh, Pa., in a Paper recently presented to the American Electrochemical Society at Pittsburgh, described an electrolytic process for removing oxides from the surface of iron, steel and other metals without impairing their physical properties. Hydrogen is absorbed rapidly by iron and steel when pickled either chemically or as cathodes electrolytically in acid solutions causing brittleness and a diminution of tensile strength, elongation and reduction of area. As anodes, however, both iron and steel may be cleaned effectually and quickly by electrolytical pickling, and without impairing their strength, resilience or other physical properties.

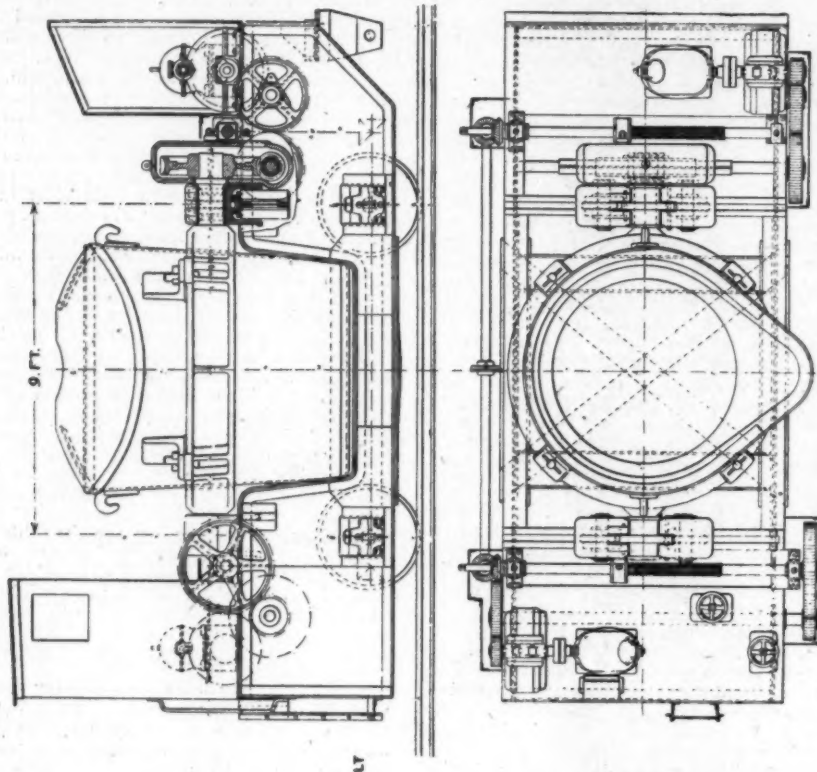


FIG. 3.—PLAN AND ELEVATION OF 24-TON LADLE TRUCK WITH SEPARATE SIDEWAYS TRAVERSE AND TILTING MECHANISM.

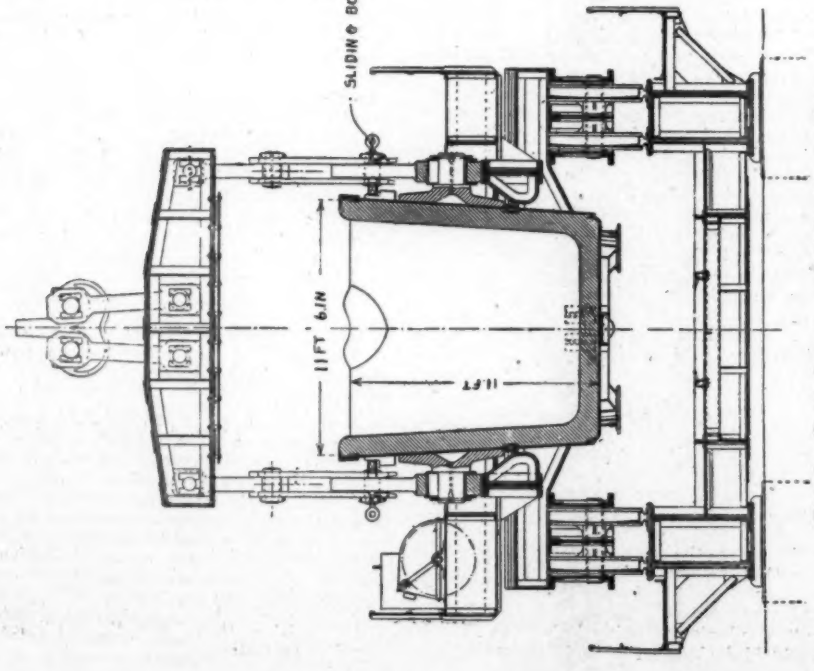


FIG. 1.—CROSS-SECTION OF 120-TON LADLE TRUCK.

High-Capacity Hot-Metal Ladles.

Both in the United States and in Continental steel works, including Germany, hot-metal ladles of 90 to 120 tons are in use. At Jones and Laughlin's works a 94-ton ladle has given excellent results. The heaviest in Germany of which we have knowledge has been designed to carry a maximum of 120 tons of molten metal, but hardly any other information is given about its details than what can be gathered from a cross-section reproduced herewith in Fig. 1. As will be seen, the truck runs on four rails, and no special tilting gear is provided; the ladle has to be lifted off the truck by a crane.

Of trucks of more modest dimensions, with ladle capacities ranging from 7.5 to 30 tons, we reproduce illustrations, with descriptions of four of these. One is a 15-ton truck on a pair of diamond bogies (Fig. 2). To prevent loss of heat by radiation the ladle is covered, a hole being provided in the centre of the top for filling, and a teeming nozzle on each side. The tilting gear is worked by an electric motor. The main underframe is carried on helical springs. In two other trucks, both of 24-ton capacity, the ladle can traverse sideways and be tilted in this position. On one of the trucks both movements are worked alternately by the same motor. The trunnions of the ladle rest on rollers, driven by a worm-gear acting on a spur-gear, with a pinion working in a rack at the bottom. The tilting of the ladle is done by a worm wheel keyed on the trunnion. In the case of the other truck (Fig. 2) each of the two movements is worked by a separate motor, and both can be worked simultaneously. The trunnions of the ladle in this case rest on small two-wheeled trucks, and the traversing motion is worked by screws. The tilting in this case also is worked by a worm gear; the worm, remaining in constant contact with its wheel, glides along a square shaft.

In a further design the ladle can be lifted and tilted at the same time as in crane working. The one illustrated in Figs. 4 and 5 is used for the transport of molten metal from the blast furnaces to the open-hearth furnaces. The ladle in this case has been made of an oblong shape in order to give it a base of large area, and thus to reduce as much as possible the height from which the metal has to be poured. The ladle moves up and down in strong guides, and is partly closed in on the top to prevent overflowing and spitting of the metal. The main frame is carried on two four-wheeled bogies, and the truck in this case is hauled by a locomotive. The gear for raising and tilting the ladle is worked by hand, the two movements being controlled by a chain working over pulleys and drums, as shown in the diagram (Fig. 6). The chain engages the wheel marked a, which is keyed fast on the trunnion, one of the ends of the chain passing over a pulley b to a coupling c, from which it is continued in two parts, d, round twin pulleys e to a concentric drum keyed on a driving shaft g. The other end of the chain passes round a pulley h, and is fixed to an eccentric drum i keyed on the same driving shaft g. When this shaft is set in motion the two fast ends of the chain are wound up at about the same rate at first, and consequently the ladle is merely tilted, but as the eccentric drum begins gradually to wind up

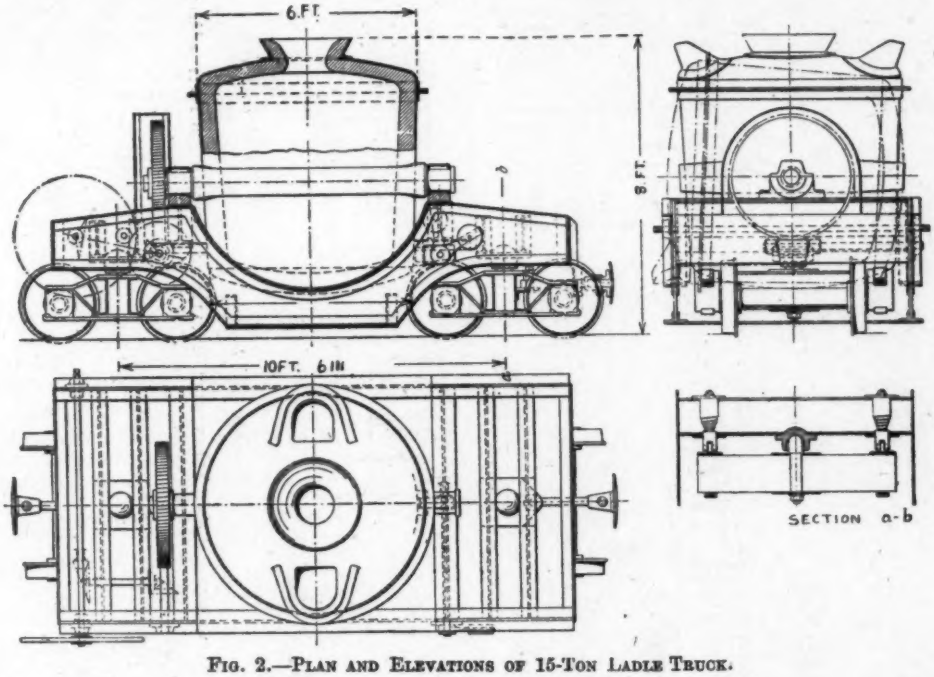
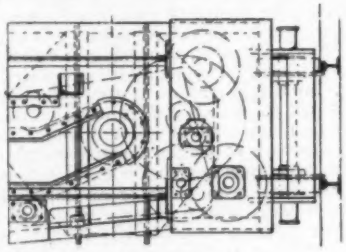


FIG. 2.—PLAN AND ELEVATIONS OF 15-TON LADLE TRUCK.

one end of the chain, at a rate somewhat faster than that at which the other end is being wound up by the concentric drum, the ladle is raised in the guides and tilted at the same time.



truck and the lifting and the tilting of the ladle are worked by special electric motors, the motor for controlling the movement of the ladle developing 30-h.p. at 600 revs. per min. In the event of a breakdown the ladle can be worked by hand by means of a crank fitted on to an extension of the driving shaft. In order to keep the motors of a uniform size, the truck is propelled by two motors of the same size as that working the ladle, their power being transmitted to the two leading wheels by a treble-purchase spur-gear.

With a view to make such heavy ladle trucks more nimble in starting and running, and thus to save hauling power, some of them have been fitted experimentally with axle-boxes with ball bearings, and others with roller bearings. Doubts were expressed at first whether such bearings would answer, considering the high axle loads some of the heavier types of ladle trucks had to carry, but the results are stated to have been quite satisfactory.

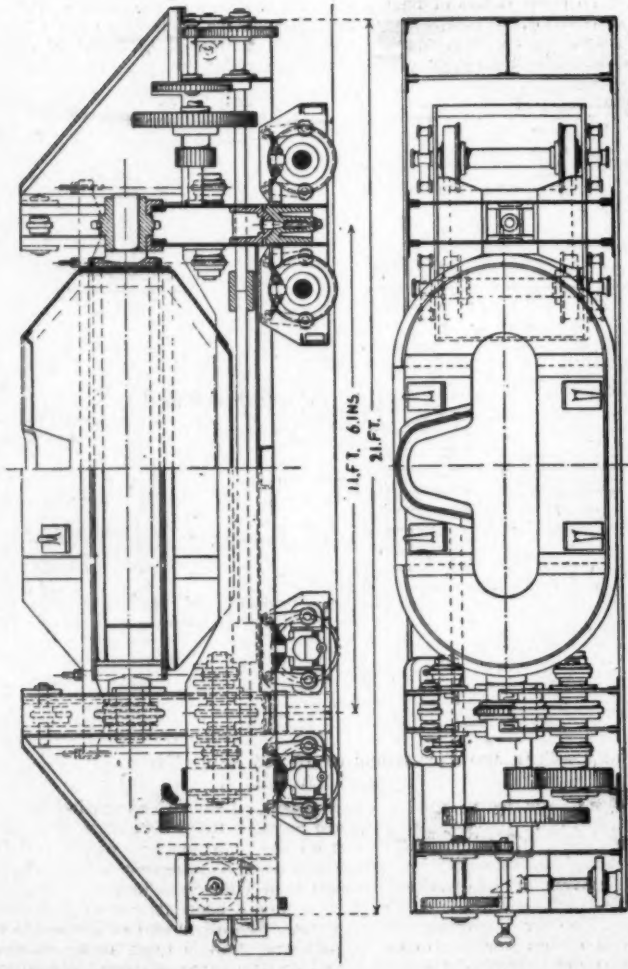


FIG. 4.—PLAN AND ELEVATION OF LADLE TRUCK WITH SIMULTANEOUS LIFTING AND TILTING MECHANISM.

In the case of another truck, which is fitted with a lifting and tilting gear working upon the same principle as the one just described, and is illustrated in Fig. 7, both the propelling of the

The Jones-and-Laughlin tilting 94-ton ladle is made of steel castings instead of plates, and is of a circular form of construction. The steel-casting form of construction, with flanged and bolted sec-

tions, enables the entire lining to be removed by a pusher when the sections are separated. The advantages claimed for the larger ladles are fewer trucks and consequently less depreciation and wear and tear, greater conservation of heat, greater elimination of "sculling," the shortening of iron runners, and a reduced number of spouts at the blast furnace.

Electric Pig-Iron in War Time.

In the course of a Paper on "Electric Furnaces in the Iron and Steel Industry," read before the American Electrochemical Society, MR. ROBERT

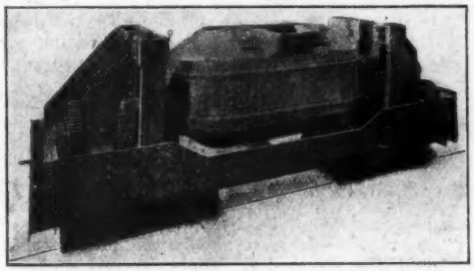


FIG. 5.—GENERAL VIEW OF LADLE TRUCK IN FIG. 4.

TURNBULL, of Welland, Canada, remarked that in the early part of 1906, when the smelting of pig-iron in the electric furnace was undertaken by the Canadian Government, the report issued some time afterwards claimed that the results of the experiments had proved that 4 tons of pig-iron could be produced per h.p.-year; in other words, this amount of iron could be produced with an expenditure of about 1,650 kw.-hours, whereas the present Swedish practice, where large furnaces are used, shows that from 2,500 to 3,000 kw.-hours are required to produce 1 ton of grey iron.

A few years ago he (the author) made some experiments with a single-phase furnace using about 650 kw., the ore used being a hematite containing from 50 to 52 per cent. metallic iron. This furnace was operated for several weeks and the expenditure of energy per ton of pig-iron produced was 2,300 to 2,400 kw.-hours. It would therefore readily be seen that to produce any considerable quantity of iron in the electric furnace large amounts of power would be necessary. His experience had not gone to show that any advantage had been gained either by lowering the expenditure of power or decreasing the gross cost of the product by the use of the shaft furnace, such as was used in Sweden, for unless the gases were utilised the shaft

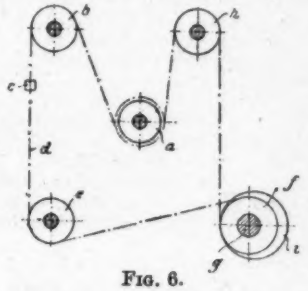


FIG. 6.

furnace became a complicated, expensive and unnecessary piece of apparatus. A well-designed ordinary electric smelting furnace with partial roof and automatic charging from overhead hoppers would produce a cheaper pig than the shaft furnace, and the first cost of plant would be considerably less.

With the war, however (continued the author), a new industry has been created for the electric furnace, which, owing to its practically low initial cost in plant and low power consumption, bids fair to become very popular, and that is the production of pig-iron from shell turnings and shell scrap. As the specifications for steel to be used in the

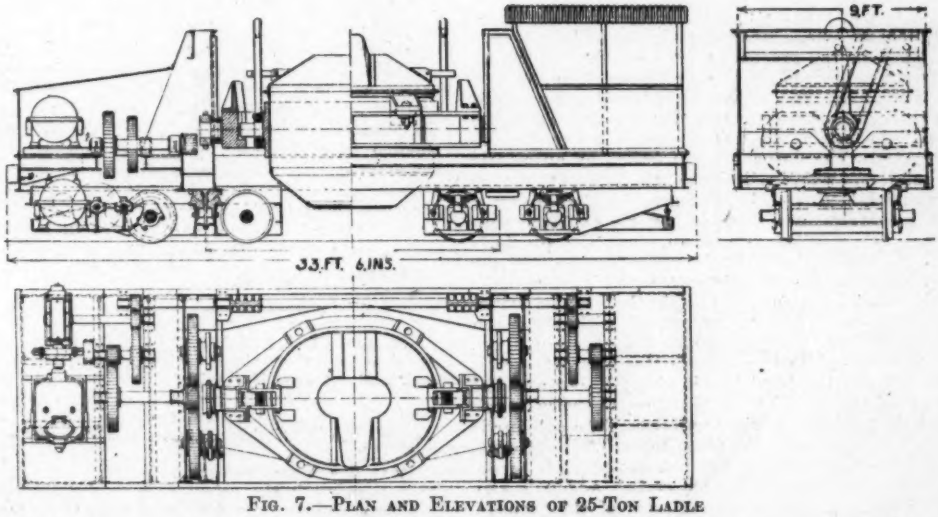


FIG. 7.—PLAN AND ELEVATIONS OF 25-TON LADLE

manufacture of shells call for low phosphorus and sulphur, it is possible in the electric furnace to produce a low-phosphorus pig-iron from such scrap at a figure which, given the present selling price of low-phosphorus pig-iron, yields a handsome profit, while very little refining is necessary. Any type of steel furnace can be used for this process, and it is not even necessary to have a furnace of the tilting type when little refining has to be done, as by special manipulation of the slag in the furnace, a certain amount of phosphorus can be removed, and sulphur is always to some extent eliminated by the basic slag employed.

The possibility of this process was first brought to the writer's attention in the fall of 1916, and experiments were immediately undertaken in a small furnace at Orillia, Ontario. These experiments having proved the process to be a feasible one, a new single-phase furnace was built and has been in successful operation since January of the year 1917. From 6 to 7 tons of low-phosphorus pig-iron is being produced per twenty-four hours, the amount of power used on the furnace being about 250 kw. Furnaces for this work have since been installed at St. Catharines and Collingwood, Ontario, also at Shawinigan Falls, Quebec, and a number of furnaces are now operating in the United States.

At St. Catharines the furnace is of 6-ton capacity, three-phase, operated by Packard transformers of 1,200 kw., but only 700 kw. is being used at the present time, owing to the shortage of power. The daily output is round about 20 tons. It is estimated that the production will attain 35 tons with the full power of 1,200 kw. The operation is in many respects similar to the making of steel in the electric furnace, the refining process for the elimination of phoshorus being somewhat different. The charge consists of shell turnings, the necessary carbon base (which may be charcoal, coke or fuel), ferro-silicon and lime. Manganese is not added, as care is taken in the process to conserve the manganese already contained in the turnings. The furnace is of the fixed type, with a carbon bottom and silica brick lining; there are two charging doors and one tap hole, similar to what is used in open-hearth furnaces. The furnace is controlled by automatic regulators, which eliminate to a great extent manual labour on the furnace, besides giving a much steadier load than is possible by hand control. The product is cast in sand, the pig beds being placed about 30 ft. from the furnace. In the Orillia plant the iron is cast into iron moulds, which make a better-looking pig than sand-casting. The return in iron as compared with the scrap charged is about 95 per cent., and as about 5 per cent. is added to the iron in the form of carbon and silicon, the total loss is about 10 per cent. of scrap charged. The pig produced is very tough and the analysis is fairly uniform. The sulphur is 0.028 per cent. and the phosphorus 0.030 per cent. The carbon is very rarely over 3 per cent.; from this point onward any extra carbon added is very destructive to the lining and roof of the furnace. A roof will last from 150 to 200 heats; the roof conditions are being gradually improved, and 300 heats may yet be realised for one roof. The load factor in making the iron was 68, including five shut-downs.

The process is not a new one, as attempts were made several years ago to make pig-iron from scrap steel, but the cost was found to be prohibitive. The writer also made some experiments in operating the pig-iron furnace for ore, before mentioned, by mixing 50 per cent. each of scrap and ore in the charge. The result was an increased production from about 6 tons on ore alone to 11 tons with the mixture. The same amount of power was used in both cases.

Whether this process will be feasible after the war and when normal conditions are again with us is not a settled point. The cost of production is at present high, and would be prohibitive under normal conditions. It must be remembered, however, that costs to-day are possibly 50 per cent. higher than they were three years ago, and it is the writer's conviction that, provided future experiments find a means of eliminating phosphorus from the iron without removing the slag, the process can be profitably operated in normal times, at least in Canada, where low-phosphorus pig-iron is always a dollar or two higher than in the United States.

In conclusion, the writer would like to call the attention of all those interested in steel furnaces to the roof coolers, which are placed around the electrodes in order to keep the bricks at that point as cool as possible. Recent practice at St. Catharines has shown that the life of the roof can be prolonged materially by correct application of these roof coolers, especially the ring of bricks around the electrodes. These coolers should be made to the exact form of the roof, and should rest on the bricks which form the ring around the electrode, and not on any packing between these bricks and the cooler. They should not be flanged, but cast to a special form, so that the cooling water will be at an equal distance from all outside surfaces.

In his reply to questions raised in the discussion of his Paper, Mr. Turnbull stated that the steel-makers using his iron had found no difference in the quality of steel produced in the open-hearth, and that he had no record of tests of the iron itself as cast. It was a fact, however, that the pigs were much tougher than ordinary low-phosphorus iron and harder to break, rendering it necessary to be careful in making the pig beds and the connections between each pig. He believed it possible to make iron on a consumption of 500 kw-hours per ton on integrated power. As to the content of combined carbon in his product, it averaged about 1.60 per cent. when the total carbon was 2.70 per cent., leaving only 1.10 per cent. carbon present as graphite. The electrode consumption averaged 45 to 46 lbs. per ton of iron produced.

THE LUDLUM ELECTRIC FURNACE.—This is a new American three-phase tilting furnace, for melting down and refining, if required, iron and steel scrap, the 11,000-volt, 40-cycle current being stepped down to about 95 volts in a 1,500-kw. transformer for a 10-ton furnace, and in a 750-kw. transformer for a 5-ton furnace. The three vertical electrodes, arranged in a straight line, pass through the roof, and one of the main points in the patent claim is that the central electrode dips into the metal bath, while the outer two are stopped short just above the slag. The hearth is elliptical in plan and dished out to an arc, both in the longitudinal and the cross section, without straight walls, angles or corners, and is covered by a low arched roof. There are two doors, one at each end of the major axis, with one of them arranged as a pouring spout. The Ludlum Steel Company, at Watervliet, New York, is now installing a third 10-ton furnace and contemplating building a fourth.

An Engine Cylinder Pattern.—I.

By Joseph Horner.

The illustrations are those of one of a pair of cylinders for the steam crab of an overhead travelling crane. They are bolted to the outsides of the steel frame plates of the crab, and the steam chests pass through holes cut in the plates, to bring the valve gear within the frames. The concave guide for the cross-head of the piston rod is cast in one piece with the cylinder, and with the foot, which is bolted to the frame plate. The type, variously modified in its details, is one that is very common in steam crane work; that is—the guide and cylinder are cast in one piece, the foot is shaped for different ways of attachment, and the steam chest passes inside the plate. It is used on cranes as well as on crabs when the cylinders are outside and the valves and gears within—an arrangement which gives the maximum room within the frames for the gears for hoisting, slewing, etc.

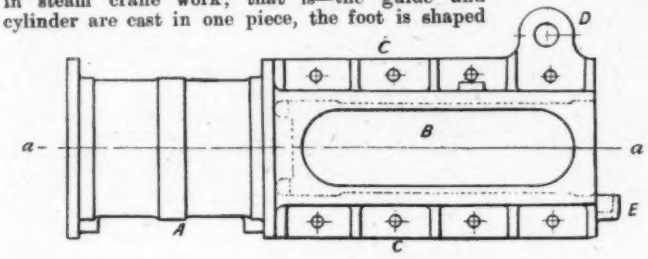


Fig. 1.

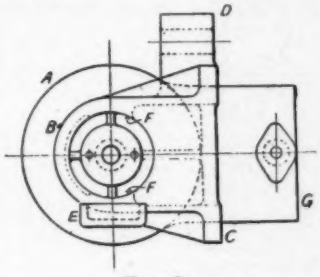


Fig. 3.

The references to the views and parts which will be required when going through the pattern details are as follows :—

Fig. 1 is a side elevation, showing the outside of the cylinder body A, of the guide B, the foot of flange C, which is bolted to the frame plate, the lug D, in which the weigh shaft with the rocker lever for the link motion pivots, and E, the waste oil cup at the end of the guide. Fig. 2 is a longitudinal section taken in the plane *a*—*a* of Fig. 1 with the preceding refernces repeated, with these additions :—F shows the bottom curved guide facing for the cross-head, G is the steam chest, HH are the steam passages, J is the exhaust passage. Fig. 3 is an end view at the guide end, with the same references so far as identical parts are visible. Fig. 4 is a cross-section through the cylinder and exhaust in the plane *b*—*b* of Fig. 2. Fig. 5 is a view looking into the steam chest against the valve face.

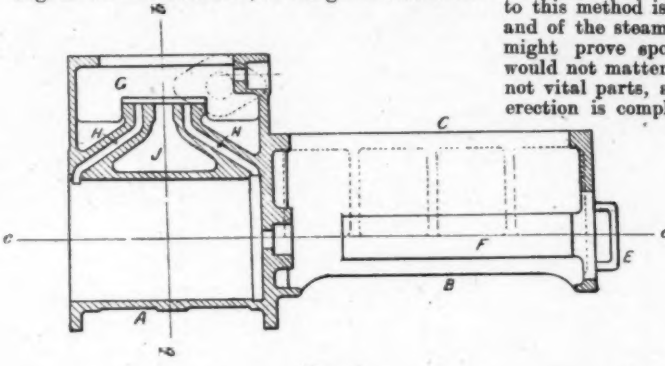


Fig. 2.

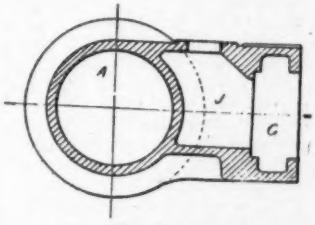


Fig. 4.

Unlike some cylinder castings, this example offers three reasonably suitable alternatives in moulding. We may very briefly state these from the point of view of the pattern-maker, who is responsible for the method of moulding to be embodied in the pattern construction.

That the pattern is to be made in halves is a foregone conclusion. The first idea that might arise would be to divide it along the plane *c*—*c*, Fig. 2, with the valve face upwards, which might be backed up by several specious reasons, the chief of which is that the guide core would have excellent support with prints at bottom B and top C, the lower one corresponding with the concave ended opening, the upper one with the open space between the flanges that form the foot C. The chief objection to this method is that the tooled faces of the foot and of the steam chest flange, coming in the top, might prove spongy. That it might be urged, would not matter so very much, because these are not vital parts, and they are not visible when the erection is complete. But the cleanliness of the slide valve face is of the first importance, since blow holes, specks, or unsoundness there entails leakage of steam, or scoring of the valve face. This should, therefore, either be cast downwards, or else sideways. Yet another objection is that of having to hang the steam chest core in the top box, with the risk of crushing the passage cores when closing the mould. True, these risks are surmountable by the exercise of a little care; the greatest objection lies in the location of the valve face.

The next suggestion might be to cast the valve face downwards, the pattern being jointed along

c—*c* as before. That would secure sound metal in that face, and ample support for the guide core, in this case that of the large print that cuts through the opening in the foot C. But another difficulty arises, one caused by the projecting flanges on the foot C—compare with the end view, Fig. 3. Either a joint must be made in the mould along the backs of these flanges, entailing the employment of a three-part box or of loose draw-back plates; or the flanges, with their brackets, must be skewered on the sides of the pattern, to be left behind in the mould, as loose pieces, to be withdrawn laterally. The same remark applies to the lug D. There is no particular difficulty entailed by leaving these portions loose, because the widths are narrow, and the open mould previous to coring is of ample width to permit of withdrawing the loose pieces, of mending up, and of blackening. Still, a moulder would prefer not to have this extra work thrown upon him if it is easily avoidable.

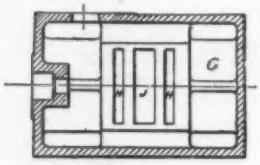


FIG. 5.

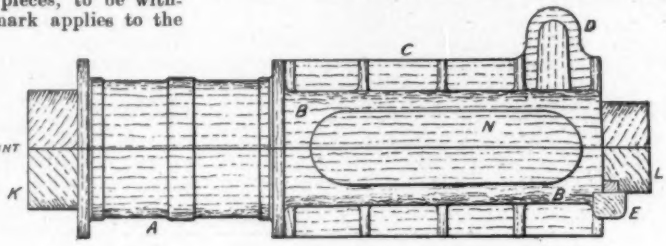


FIG. 6.

Considering next the passage cores for H and J in Fig. 2, it is evident that when the main core for the cylinder is laid in over the passage cores, one cannot see whether these have been pushed out of place by contact with the main core. This is not a very serious difficulty, because the moulder tries the main core in tentatively, using powdered chalk, whiting, lime, or thin clay wash, to see if contact has occurred with the passage cores, removing the main core for the purpose. Risks of a crush or of displacement are thus minimised. Yet these considerations have some weight when making comparisons of methods, and before deciding on this method of moulding with flanges and passage cores in the bottom, a foreman would consider another alternative, that of jointing the pattern and mould along the plane *a*—*a* in Fig. 1, and note how that compares with the previous one. Jointed thus, the amplest support can still be afforded to the guide core, nothing need be left loose, the steam chest flange, and the valve faces stand vertically, from whence air and sullage can rise away, and the passage cores can be seen when the main core is in place and the mould is ready for closing. No objection suggests itself to this method, which is the best one to be adopted. The pattern in succeeding figures is shown as constructed in this way.

The pattern is shown as being made for standard service. In this class of work a large number of cranes is seldom included in a single order. Five, ten, or twenty are usual. But these are repeated in succeeding years from the same or different sources, and therefore the patterns must be constructed so well that they will retain their shapes for many years. They are lagged, and built-up of numerous pieces, much in the manner shown, although naturally some of the details would be varied in the hands of different craftsmen.

A comparison of the drawings, Figs. 6 to 11, will enable the construction to be understood. Fig. 6 is an elevation looking from the outer side, or that farthest from the foot. Fig. 7 is a plan view. Fig. 8 shows half the pattern laid open in its joint face. Fig. 9 is an end view looking towards the guide. Fig. 10 is a cross-section of the pattern taken through the guide, and Fig. 11 a cross-section through the centre of the cylinder and steam chest.

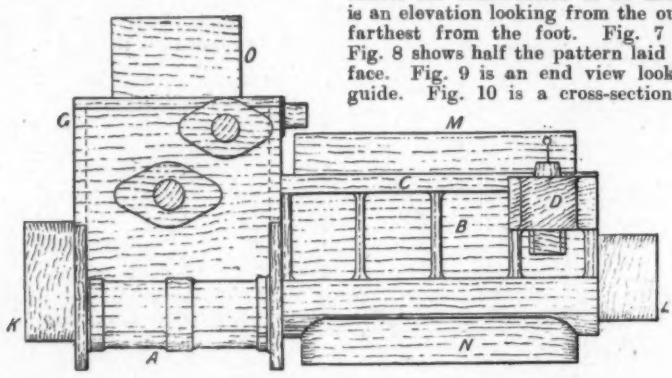


FIG. 7.

From these views it will be seen that the cylinder and the guide are made as separate lengths, Fig. 8, jointed at *d*, to be united with screws, and with a dovetailed key. Both are built with lagging strips disposed to correspond with their sectional shapes—compare with the end views, Figs. 10, and 11. The cylinder flanges are shown as prepared separately, with the choice of two methods of fitting them. In Fig. 8 they are plain discs, checked over and attached to the ends of the lagged body, and the end print is also a disc

screwed on the outside of the flange. The very slight risk of displacement of the print is avoided by adopting the alternative method shown in the detail, Fig. 12, but this requires thicker lagging, and a thick lagging block to include the print and a portion of the body.

The details of the attachments to the main body

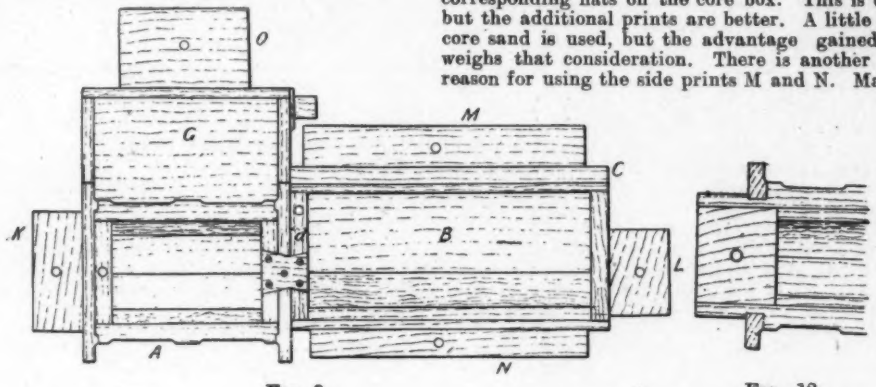


FIG. 8.

FIG. 12.

are clearly shown. The various reference letters correspond with similar lettering on the views of the casting, Figs. 1 to 5, with the following additions:—

The support of the main core is provided for by the prints K and L, and by prints M and N,

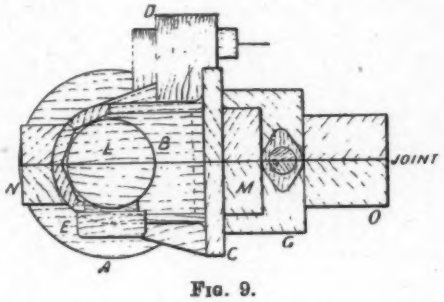


FIG. 9.

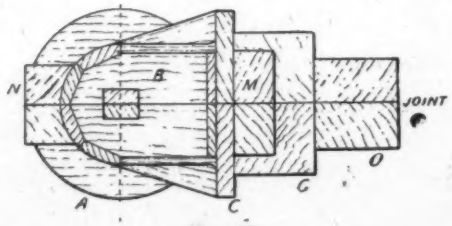


FIG. 10.

the cores for the cylinder and guide being combined in one piece, as will be explained subsequently. M is the print that takes out the open space, which is surrounded by the flange C—compare with Fig. 2. It cuts through to the guide formation, while the print N provides a support to the other side, cutting out the concave-ended opening B, seen in Figs. 1 and 6. The prints M and N are not strictly necessary, but they afford additional security. Without their aid the core, being carried only in the axial print impressions K and L, would be difficult to set, so that the guide facings F, see Fig. 2, should be exactly central at top and bottom, and so that the core should cut through on the faces B and C. The risk would be diminished by cutting a flat on each of the prints K and L, and putting corresponding flats on the core box. This is done, but the additional prints are better. A little more core sand is used, but the advantage gained outweighs that consideration. There is another good reason for using the side prints M and N. Making the cylinder and guide cores in one piece, they are connected by a very small neck, which occupies the place of the stuffing box, see Fig. 2. Although iron rods are passed through, the core is weak there, and will sag, and has to be supported with chaplets adjacent, but keeping clear of the cylinder bore and the guide face. Using prints M and N they may be dispensed with. O is the print that carries the steam-chest core. It is made of good width to counterbalance the overhang of the core. The passage cores are carried in this one, so that no provision for these appears on the pattern.

The lug D for the rock shaft should be cored, although it can be drilled easily in the solid metal. The reason for coring is to prevent risk of a draw occurring in the mass, because coring lessens the

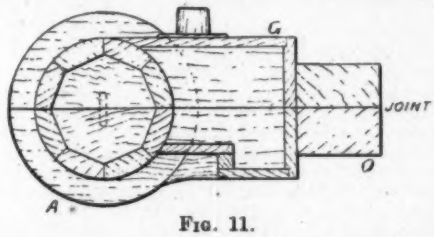


FIG. 11.

metal, and favours equal shrinkage. A drop print on one side, and a round print skewered on the other, Figs. 7 and 9, is the best provision. If the lug is cast solidly, the risk of the occurrence of a draw will be lessened if a riser is put over it and fed. The waste oil cup, E, Figs. 2 and 3, is cored with a print shown in Figs. 6 and 9. This is curved round to fit the round print L, and is inserted before the main core is. The edges of the print impression regulate its position in lateral directions, and a couple of chaplet nails support it vertically, and give the thickness in the bottom of the cup. There are some facings for steam and exhaust, and prints on the steam chest which call for no further remark.

Swelling of Zinc-Base Die Castings.*

By H. M. Williams.†

When die castings are properly made, they are dense, accurate to dimension, and well finished. However, there are certain limitations to the use of die castings which must be given consideration in addition to the cost of material and production. These limitations have to do with the physical properties of the alloy and its behaviour under the different conditions to which the part will be subjected in service.

We have had the die casting process in successful operation for several years, and many new parts have been gradually added and produced in zinc-base metal. Complaints were not numerous, and those received were generally passed up as due to the occasional defective casting. Our Cuban office had registered most of the complaints. They claimed that the metal swelled and caused trouble by binding. The castings causing most of the trouble were type wheels. These wheels are approximately 2 in. in diameter, and have a hub ¼ in. in diameter, cast on one side with a recess on the other in which the hub of the next wheel runs. The dies gave 0.001 in. play between the hub and the recess. This allowance had always been sufficient for the machine's bronze wheels, which had been in satisfactory service for many years. It seemed incredible that this alloy should swell after having been die-cast and carefully inspected with gauges. At last, one of the stock-keepers, in looking over some old wheels, found that they would no longer run together, and, further, that they were 0.005 in. larger than the die in which they had been cast. This discovery led to the following investigation :—

In October, 1914, twelve type wheels were carefully measured at four points on each wheel. Six of these were sent to the Havana office, the other six were kept at the factory. Six months later the wheels were returned and re-measured. The results were as follows :—

	10/6/14.	4/6/15.
Average size of wheels sent to Havana ..	2.0075	2.0145
Average size of wheels remaining at factory	2.0077	2.0094

The wheels sent to Havana swelled 0.0070 in., while those held at the factory swelled 0.0017 in. This test confirmed the original complaints, and showed that there must be some conditions which caused the rate of swelling in Cuba to be so much greater than in United States.

To get quick methods of determining the swelling coefficient of the various samples which we wished to test made it necessary to develop methods of producing the swell which would at least be comparable with the Cuban conditions, and if possible much more rapid. The following conditions were created and adopted for increasing the rate of swell :—

1. Heat at 98° Fahr. in moist air.
2. „ 176° Fahr. „
3. „ 212° Fahr. in dry air.
4. Heat in steam at 10 lbs. and 45 lbs. pressure.

Comparing the first condition with actual Havana conditions, we sent five wheels, made with 1 in. brass centres, to Havana, and kept five wheels at 98 deg. F. in moist air. The wheels sent to Havana were returned after five months. They had swelled 0.0035, while those which were heated at 98 deg. F., in moist air swelled 0.0085 in.

We consider that the effect of moist air at 176 deg. F. is the most severe condition, which will cause rapid swelling of this alloy, and yet not destroy the surface of the wheels.

The following lines of investigation were followed up to determine the cause of the swelling :—

(1) The effect of casting temperature.

The casting temperature was varied between wide limits. This did not have any influence on the swelling.

(2) The effect of casting pressure.

The pressure was varied from 15 lbs. per sq. in. to 200 lbs. per sq. in. without changing the tendency to swell.

(3) The effect of annealing.

Castings were annealed at various temperatures in ovens and oil baths. They were given different rates of cooling, but this did not overcome the difficulty.

(4) The effect of oxidation.

Oxidation was prevented by nickel plating and by lacquering. This procedure did not eliminate the swell, as is shown in the following table :—

Swell after 60 days.	At Room temp.	At 212° Fahr.	At 176° Fahr.
Regular metal	.0003	0.019	.0200
„ (nickel-plated)	.0006	.0016	.0131
„ (lacquered)	.0004	.0024	.0157

(5) The effect of changes in the composition of the alloy.

The zinc-base alloy which we used for our die-casting work analysed approximately as follows :—Copper, 5.50 per cent.; tin, 7.50 per cent.; aluminium, 1 per cent.; zinc, 86 per cent. The first change was a decrease of the copper content. It was found impracticable to reduce the copper below 3 per cent. However, this reduction did not reduce the swelling tendency.

The fact that certain aluminium alloys after a time fail by cracking and warping, suggested the work on the effect of different percentages of aluminium. These alloys were made and compared with the regular metal. The approximate analyses were as follows :—

	Copper.	Tin.	Alumin-ium.	Zinc.
Regular metal	5.5	7.5	1.0	86.0
Alloy No. 1	3.0	7.5	0.5	89.0
„ No. 2	3.0	7.5	0.25	89.25
„ No. 3	3.0	7.5	0.10	89.40

Swell in 60 days :	Room Temp.	At 212° F.	At 176° F.	At 98° F.	45 lbs. steam. 1 hour.
Regular metal ..	.0003	0019.	.0200	.0043	.1004
Alloy No. 1 ..	.0003	.0010	.0147	.0022	.0509
„ No. 2 ..	.0001	.0014	.0139	.0031	.0393
„ No. 3 ..	.0003	.0002	.0003	.0001	.0020

These alloys were cast into type wheels for comparison. The above table shows the effect of the test.

Considering the test in moist atmosphere at 176 deg. F., it will be noted that the regular metal containing 1 per cent. aluminium swelled 0.0200 in. on a 2-in. diameter, while alloy No. 3, containing 0.1 per cent. aluminium, swelled 0.0003 in. These figures are averages of readings in six different wheels at four points on each wheel. The result shows conclusively that the reduction of the aluminium to 0.1 per cent. will practically eliminate the swelling of these wheels.

Confirming these results, we have several wheels from the same casting as the one used in the above

* Read before the American Institute of Metals, September, 1917.
† Remington Arms U.M.C. Company, Bridgeport, Ct.

tests. These were made in November, 1915. The wheels made from the regular metal and alloys No. 1 and No. 2 have swelled to such an extent that the hubs will no longer enter the recesses, while those made from No. 3 alloy will run together as nicely as when first cast.

One point should be mentioned in connection with the regular metal. If this alloy is made, run into pigs, and allowed to cool slowly as in regular foundry practice, no swelling will take place. This has been demonstrated on a 0.732 in. cube which has been kept in a moist atmosphere at 98 deg. F. for over two years.

Box Squares.

By CHAS. A. OTTO.

The accompanying illustrations represent what is usually termed a vertical plumb or box square. It is a handy device, which will be found very

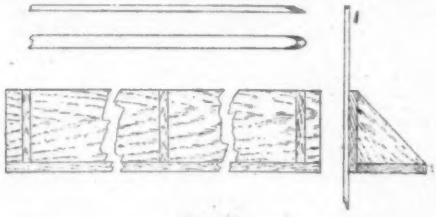


FIG. 1.

convenient to the pattern-maker in transferring lines to irregular surfaces which do not lend themselves readily to the use of the square or even of a flexible rule.

The device can be made in a very short time in wood, which will meet all ordinary requirements.

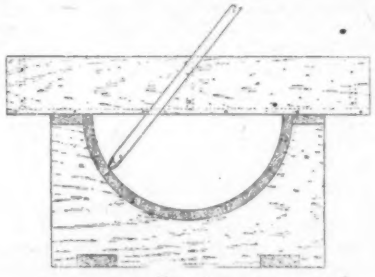


FIG. 2.

It consists of a portion of a square box, supported by means of brackets, as shown in Fig. 1. The marker, shown on the upper part of Fig. 1, consists of a straight piece of steel, ground back on one side to provide a circular cutting edge, in a similar manner to that of a round nose for lathe work, only more acute. Care must be taken in making the scribing edge continuous with the marking face, as shown in the right-hand diagram of Fig. 1. This appliance can be used for drawing lines at right angles to a centre line of a core box, or at any angle which may be required, as in the case of core boxes for Y pipes, the supports for valve seatings in valve boxes, etc. The method of using it is shown in Fig. 2, care being necessary to keep the marker flat against the box square. It is also useful as a guide to a cutting tool when recessing a box; for this purpose it is advisable to screw it to the joint temporarily. Fig. 3 shows the application of a little different form of box square for external work. The square shown in Fig. 1 cannot

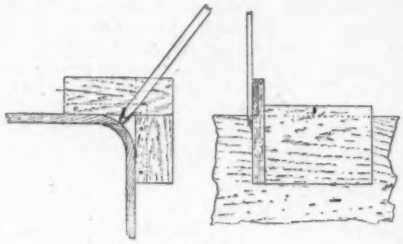


FIG. 3.

readily be adapted for this class of work, owing to the presence of brackets. In this instance the required strength is obtained by means of the flange piece which serves as the operating face. This type is also useful for marking horizontal lines on cylindrical bodies, especially when developing irregular contours for fitting branches to pipes.

ELECTRIC STEEL IN AUSTRALIA.—The first plant of the Australian Electric Steel, Limited, at Alexandria, Sydney, is equipped with a 2-ton Electrometal two-phase furnace, and current is supplied from the 5,000-volt three-phase circuits of the City Council through transformers. The plant has been in operation for nearly a year, and its output is principally castings low in carbon, and special alloy steel castings for mining and electrical work; the charge is common steel scrap and pig-iron. The company has already commenced the erection of a similar plant in Western Australia. The transformers are Scott-connected.

A 1,300-TON MIXER.—The Youngstown Sheet & Tube Company, Youngstown, O., U.S.A., recently installed a hot-metal mixer with a capacity of 1,300 tons. The cast steel shell, 24 ft. 2 in. outside, and 20 ft. 2 in. inside diameter, has a 24-in. silica brick lining. The mixer, the top of which is 53 ft. 7 in. from the ground, rests upon a solid concrete foundation, 25 by 40 ft., and is tilted electrically, the molten metal being received by a 65-ton ladle, which, supported by two double trunnions, rests on two standard railway trucks. The ladle is placed on a platform weighbridge directly under the spout of the mixer so that when the iron has been poured no time is lost in weighing. An electric locomotive transfers the ladle from the mixer to the open hearth. A brick wall 30 ft. high and 13½ in. thick forms the side of the building nearest the pouring side of the mixer. This wall contains several arched openings 10 ft. high. In case any iron is spilled while being poured, it will flow to the ground through these openings. All steps and platforms in the immediate vicinity of the mixer are paved with brick. The operator's platform is 44½ ft. above ground level. It contains a grate-bar opening, 5 by 5 ft., through which the operator may look and determine the amount of metal contained in the ladle. Pits for relining and drying ladles are placed at each end of the mixer. Coke oven gas is employed for drying newly-lined ladles as well as for keeping the metal warm in the mixer. The building which houses the mixer is 106 by 80 by 94 ft., and contains two electric, double-drum cranes, each of a capacity of 80 tons, and a maximum lift of 75½ ft.

Gas-Fired Furnaces.

In the course of a recent lecture before the Manchester and District Junior Gas Association, Mr. Arthur Forshaw, M.Sc. (chief chemist to Messrs. John Wright & Company), discussing "Gas Furnaces: Their Design and Manipulation," said that when furnaces came to be lined, the ordinary coke furnace cost less than the gas furnace, for the reason that in coke furnaces a lower class of refractory could be used than in gas furnaces. In coke furnaces the bricks were in contact with the coke, and they were subject to corrosion from the ash and to erosion due to the continual rubbing of the coke as it passed down the combustion space. Therefore the combustion space was subject to enlargement. But up to a certain point this did not matter much; it raised the fuel consumption somewhat, but in normal times coke was comparatively cheap. In the gas furnace, on the other hand, the combustion space must be kept constant within narrow limits, or the consumption of the comparatively costly fuel rose materially.

As to how long a lining could be reasonably expected to last, it was difficult to get definite figures, for they were, as a rule, not in a position to follow the performance of a furnace in an outside foundry for a long enough time. A figure of 500 melts for small pit furnaces melting gunmetals or brass was not unreasonable, and with care there was no reason why this should not be as high as 800 melts, particularly for brass, while for aluminium it should be considerably more. The more often the lining is fettled the longer it lasts. It was well worth considering the expedient of paying furnace operators a bonus on the life of the linings. In general it would appear that speeding-up production paid; but each furnace must be specially designed for the particualr purpose in view.

The renewal of pots or crucibles might be a serious item unless due care was taken. A new pot should be carefully annealed immediately prior to use—fourteen days' steady annealing at 150 deg. C. was not too much. It helped very greatly if the pots were stored in a warm, dry place; and firms who, in addition to brass melting, did their own rolling and annealing found the top of the annealing ovens a convenient place, while foundries often stored the pots in core ovens —a good practice. Such procedure could take the place of the annealing. The main idea was slowly to get rid of all moisture in the material of the pot.

In gas melting the correct setting of the gas and air in relation to one another was primarily made in order to effect the most economical melting, but another reason for taking particular care of the quality of flame was to avoid the effect of an oxidising flame upon the graphite of which the pot was largely composed. A further cause of short life of pots was occasionally met with—corrosion on the inside of the pot at the level of the molten metal. The only advice that could be given at the moment was to try the use of different fluxes and to limit them to as small a quantity as was permissible, also to remember that a perfectly even flame of the correct quality seemed to have a beneficial influence on this inside corrosion.

He knew one brassfoundry where the average life of coke-fired (60-lb.) crucibles was about thirty to thirty-five melts, a figure which appeared fairly to represent ordinary coke practice. For these people they installed a battery of 60-lb. pit-type air-blast crucible furnaces, and they now averaged eighty to ninety melts per pot. In fact, he had seen pots after they had done 100 to 105 and even 110 melts that appeared good for several more melts, but had lost shape through the continual pressure of the tongs in pouring, and which were discarded for that reason. In another works, where their 300-lb. tilters were in use melting brass, 100 melts per pot were regularly obtained, and they had attained as high as 105 melts per pot. In that foundry they paid the workmen a bonus on every melt per pot above a certain number. It was only fair to say that in both the cases cited high pouring temperatures were not necessary. Results like these could not be obtained with gunmetal and cartridge metal, which had to be poured at much higher temperatures. In the melting of aluminium, on the other hand, a high figure should be obtained. In a works where they had installed several 600-lb. tilters, the foundry manager informed them that he was obtaining 150 melts per pot, and was very satisfied. Cupro-nickel caused a short life of pots, as this alloy had to be raised to a temperature of approximately 1,370 deg. C. before pouring, and the surface of the metal must be protected by flux. In coke melting, using the 250-lb. size (pit type) the average life was four melts. In a large installation made by them this size of pot was giving an average of about fourteen melts per pot, while with the 60-lb. size an average of from eighteen to nineteen melts per pot was obtained.

A pot seemed to give longer life if it could be made to glaze over the outside. Glazing very often occurred without taking special steps to ensure it; in fact, it occurred in a gas furnace when the setting of the burners and conditions generally were correct, but sometimes reagents such as waterglass, and the like, were painted on the outside of the pot before use. A further cause of damage to pots was careless charging. If two cold ingots, for instance, were wedged together, they would expand as they heated, and often burst the pot or damaged it severely.

Fuel Consumption.

In regard to fuel consumption it was difficult to select figures which would correctly represent average practice. It might be argued that one should quote figures for definite pouring temperatures, with the appropriate increases for definite increments of temperature, but the difficulty was that so very few founders knew what their pouring temperature was. A cause of wide difference in the melting figures for the same metal was the physical state at the commencement. Gunmetal might be put in the pot in the form of ingots of the alloy, and this would give the lowest possible melting figure. Very often, however, the alloy was prepared from its constituents, and more gas was required to make the alloy than to melt it. The more finely divided the metal was the more gas was required to melt it. Usually they found ingots were the easiest to melt, and after them heavy scrap like runners. Light scrap took rather more gas, while swarf might need double or often treble the gas necessary for ingots. In general practice, apparently mixed charges were fed indiscriminately, but from their experience they

considered it best in gas practice to charge the lightest scrap first, the heavier next, finishing up with the heaviest.

The following results were submitted, obtained in the foundries of independent firms and including no purely laboratory tests :—

Melting operation.	Size of crucible.	Average cu. ft. gas per lb. metal.	Average time minutes) per melt.* Gross.	Net.
Melting common brass ingots and scrap for castings 60/40	60-lb. pit.	2.40	35½	25
Making gunmetal for castings 88/10/2	100-lb. pit.	3.37	48½	39
Making cartridge metal strips 70/30	300-lb. tilter.	3.54	72	50
Making cupro-nickel strip 80/20	60-lb. pit.	8.5	59	53
Melting aluminium ..	600-lb. tilter.	3.2	49	34
Making 70/30 cartridge metal	600-lb. tilter.	3.0	93	81

* The difference between gross and net melting time represents pouring and charging and will vary in different foundries according to the rate at which the mounds can be poured.

Annealing operation.	Load.	Duration	Cu. ft. per ton.
Annealing high-speed steel ..	3½ tons.	8 hours.	3,000
Annealing steel	3½ „	15½ „	6,000
Annealing cast-iron parts packed in filings in boxes ..	2,000 lbs.	3 „	3,360

In practice, apart from laboratory tests, the use of an efficient pre-heater would often reduce the gas consumption by, roughly, one-third. It was necessary, however, to ensure that should some parts of the metal be heated more than others and run at the edges, as often happened, these small amounts of molten metal should be directed into the pot; otherwise they lodged in the pre-heater or ran down the furnace linings, with the same result in each case—viz., corrosion of the brickwork.

The lecturer laid special emphasis on the need for uniformity in the quality of the gas supplied by the gas undertakings. Owing to present circumstances, calorific value had, on the whole, tended to become more uniform. Gas engineers had to be content with what they could get in the way of supplies of material, and there had been a general tendency for the higher calorific values to drop. While any movement towards uniformity in this direction was to be welcomed, it was necessary that it should not take place at the expense of uniformity in other directions. Gas-heating engineers could not look with equanimity on the reduction of calorific value if it was brought about by dilution with inert gases, nor could they welcome continually varying percentages of water gas or high specific gravities. It was highly important in many gas-furnace operations that a high flame temperature should be attained; and as the percentage of incombustibles rose this property was impaired. Again, water gas required, volume for volume, less air than the coal gas it replaced. A sudden jump from, say, 10 per cent. to 35 per cent. of water gas—a not unknown happening—had a very considerable effect on a flame that had been set for the former percentage. Generally speaking, they did not mind low calorific value—they had melted much metal by blue water gas alone—but they did ask gas engineers to assist them in the matter of flame temperature, unfluctuating pressure, and unvarying percentages of constituents likely to upset flame quality, and as far as possible to standardise the chief product of the gasworks, so that, in whatever part of the country they might be, a reasonably constant quality of gas could be counted on.

Analysis of Manganese Brass.

In the analysis of the various materials classed under the term "manganese brass," or more commonly "manganese bronze," it is necessary to examine for and estimate the following elements :—Copper, zinc, lead, tin, nickel, iron, aluminium and manganese.

The following process has the advantage that all the estimations, with perhaps the exception of lead, may be carried out on one sample. The electrolytic method for separating and estimating copper is mentioned below. This is now generally admitted to be the cleanest and most accurate method. If, however, an electrolytic apparatus is not available, the copper may be removed by H_2S in the usual way.

Process.—Dissolve 2 grammes sample in about 20 cc. of 1.2 sp. gr. HNO_3. Dilute, allow to settle. Filter off and ignite oxide of tin if present. Add 2 to 4 cc. strong H_2SO_4, and boil down till bulk is suitable for electrolysis. Electrolyse and weigh copper on the cathode. The deposit on the anode will contain lead and some of the manganese. Dissolve the deposit in a small quantity of dilute HCl in a test tube. If the sample contains more than a trace of lead (see note at end), boil the solution of lead and manganese chlorides with sulphuric acid and separate the lead as sulphate. Add the filtrate from the lead to the solution remaining after electrolysis of the copper. Boil down, add about 10 cc. HNO_3 and boil down. Add about 15 cc. HNO_3 and 1 gm. potassium chlorate and evaporate. Dilute, make alkaline with NH_4OH, and boil carefully. Filter, wash well with hot water and a trace of NH_4OH. Preserve both filtrate and precipitate.

Precipitate.—Burst filter paper, wash through precipitate, add about 20 cc. HNO_3 and 1 gm. potassium chlorate and evaporate. Dilute with hot water, filter off oxide of manganese, and wash well with hot water. Digest precipitate with excess of $\frac{N}{20}$ ferrous ammonium sulphate solution (probably 55 cc. will suffice for most cases). Add 10 cc. H_2SO_4 and about 200 cc. warm water. The oxide of manganese should then be completely dissolved. Titrate excess of ferrous iron with $\frac{N}{20}$ potassium bichromate solution, using potassium ferrocyanide solution as indicated. To filtrate from manganese, add excess of ammonia, boil, filter, and wash well with hot water. Ignite and weigh the oxides of iron and aluminium. Dissolve precipitate in HCl with addition of stannous chloride. Add excess of mercuric chloride and titrate iron with $\frac{N}{20}$ potassium bichromate solution.

Filtrate.—(From original precipitation with ammonia.) Add a 1 per cent. alcoholic solution of dimethyglyoxime to precipitate nickel. Filter the red precipitate (if any) on a weighed paper. Dry in water bath and weigh.

The zinc in the filtrate from the nickel may now be estimated either by precipitation as sulphide or phosphate, or by first precipitating as sulphide, and afterwards dissolving the zinc sulphide in HCl and titrating with potassium ferrocyanide.

Notes.—Most manganese brasses contain only small percentages of lead. The lead content is usually under 1 per cent., and sometimes even under 0.1 per cent. For an accurate determina-

tion of small percentages of lead it is advisable to take a fairly large sample, say 5 gms., dissolve in HNO_3, and after filtering off oxide of tin, precipitate lead with H_2SO_4. The lead sulphate may either be weighed or dissolved in ammonium acetate and the lead weighed as molybdate.

The writer has found that the above method of separating manganese before iron and aluminium gives perfectly accurate results. It is much more reliable than the acetate separation in samples containing only small percentages of iron, such as one recently tested which contained 0.26 per cent. iron, 2.01 per cent. manganese, 2.75 per cent. aluminium.

Calculations.

Copper.—Weight of deposit × 50 gives per cent.

Tin.—Weight of $Sn\ O_2$ × 0.786 × 50 gives per cent.

Iron.—No. of cc. $\frac{N}{20}$ K_2CrO_7 used × 0.14 gives per cent.

Aluminium.—Multiply total precipitate of (AL_2O_3 + Fe_2O_3) by 50. Subtract from this the percentage of iron divided by 0.7. The difference × 0.502 gives per cent. aluminium.

Manganese.—Subtract No. of cc. $\frac{N}{20}$ $K_2Cr_4O_7$ used from No. of cc. $\frac{N}{20}$ ferrous ammonium sulphate added. Remainder × 0.0687 gives per cent.

Nickel.—Weight of nickel glyoxime × 0.2033 × 50 gives per cent.

Lead.—Weight of $PbSO_4$ × 0.683 × 50 gives per cent. in 2 gm. sample. Weight of $PbMoO_4$ × 0.564 × 50 gives per cent. in 2 gm. sample.

Zinc.—Weight of ZnO × 0.802 × 50 gives per cent.

The writer believes that if the analysis is carefully carried out, it is quite satisfactory to take zinc by difference. Though the zinc be exactly weighed or titrated, its accuracy depends on the care with which the previous separations have been done.

ANNEALING OF STEEL CASTINGS.—Herr R. Durrer, of Düsseldorf, in a short series of articles on "The Practical Application of Metallography in the Iron and Steel Foundry," published in recent issues of "Stahl und Eisen," arrives at the following conclusions as a result of his investigations:—(1) Steel castings can be improved materially by increasing the manganese content to, say, 0.8 to 1.0 per cent., the principal effect of which is to increase the strength and the ductility. (2) The improvement by annealing is relatively less in thin than in thick steel castings. (3) Annealing produces an outer skin with reduced carbon content, and consequently of less hardness and less resistance to wear. In the case of castings of ordinary quality this skin is about 1 mm. (25.4 mm.= 1 in.) thick, in castings richer in manganese it is about 0.5 mm. (4) With annealing the characteristic texture in thick and the cellular texture in thin castings disappear and a pure granular texture is produced. This change in texture by annealing becomes less apparent in proportion to the decrease in the thickness of castings. (5) In the case of steel castings rich in manganese the texture is also changed by annealing, but in the author's experiments no uniformity in the grain could be attained, and patches of fir-tree pattern remained. The author thinks that by an improved method of annealing (as regards degree of temperature, length of period of heating, rate of cooling) manganese steel castings could be further improved.

Steel Turnings and the Electric Furnace.

By JOHN A. HOLDEN.

A few years ago steel turnings were not in very much demand, and good clean turnings could be bought for 30s. per ton. The price to-day for the same metal is about £4 per ton, a figure which would, no doubt, have been exceeded but for the intervention of the Ministry of Munitions. The reason for this appreciation is not difficult to seek. The raw material for the manufacture of electric steel in the arc type of furnace consists almost entirely of turnings. The writer refers to those furnaces which are worked with cold stock. Incidentally, it may be added, in this country very few furnaces are worked with liquid charges.

Fifty 3-ton electric furnaces would consume annually 150,000 tons of steel turnings. In addition, turnings often form a portion of a Siemens charge, and sometimes they are used in blast-furnace charges. For producing electric carbon tool steel mild-steel turnings from shells are in much demand. Nickel-steel turnings are used for the manufacture of nickel-steel ingots. With a suitable grade of scrap no addition of nickel may be required, because in any type of electric furnace there is no oxidation of nickel.

Similarly, nickel-chrome-steel turnings may be profitably converted into nickel-chrome-steel ingots. In acid-lined furnaces there is little or no loss of chromium; in fact, the reactions in this furnace are comparable to those of the crucible process. In basic-lined furnace chromium may be retained or eliminated. In the former case the phosphorus would not be so completely oxidised, but nevertheless it would be confined to safe limits. It follows that for cheap production of alloy steels, such as nickel and nickel-chromium, scrap turnings containing the necessary elements should be used.

From an economic point of view, it is undesirable that alloy-steel turnings should be used in charges where the alloying elements are not necessary or desirable. Many engineering establishments do not keep all these varieties of scrap separate. They may religiously look after high-speed steel, but other alloy steels are mixed with plain carbon-steel turnings. In addition, the heaps of turnings sometimes become a dump for waste paper, or even worse refuse, etc. In those shops where the amount of scrap produced is very small, it may not be economically possible to separate the different varieties. Unfortunately there are works producing weekly as much as 100 tons of turnings consisting of only two varieties, yet they do not trouble to keep them separate.

One example will suffice to illustrate the loss when nickel steel is used in charges where nickel is not necessary. Fifty tons of 3 per cent. nickel steel scrap contain £300 worth of nickel. Taking 50 tons as a weekly average, it represents potentially £15,000 per annum. Whilst every electric steel melter desires short heavy turnings, it has been found practicable to crush the lighter turnings and obtain results equal to those obtained by the use of the more expensive and weighty turnings.

THE Crown Steel Works, Sylvester Street, Sheffield, of William Parkin & Company, Limited, were the scene of a fire on Sunday, the damage being considerable.

British Foundrymen's Association.

SCOTTISH BRANCH.

At a meeting of the Scottish Branch of the British Foundrymen's Association, on December 8, Mr. M. Riddell (Branch President) in the chair, Mr. R. R. McGowan read a Paper entitled "Cupola Notes." At the outset he stated that there was no subject associated with the foundry which had so much attention given to it as the cupola, and there were few foundrymen who had not given the subject some consideration. The Committee of the Branch had decided to place the subject of the cupola on their programme for some time to come, and invite certain members to introduce a discussion upon any phase of the subject which might be of interest to the members.

Cupola practice was a subject upon which many young foundrymen desired information, because a knowledge of the cupola was demanded from those aspiring to promotion.

The cupola was by far the most economical type of furnace yet introduced for reducing the metal from its solid to its liquid condition; the consumption of fuel per metal melted was about 10 per cent. against about 75 per cent. for the crucible and air furnaces. When considering the cupola it was very difficult to ignore the many scientific principles which are set into action in reducing a metal from its solid to its liquid condition. It was not the intention of the lecturer to enter into these principles in detail, but the paper would not be complete without giving the matter at least a passing reference. After referring to the preparation of the cupola for a day's campaign, the lecturer explained that the object of the coke bed was to support the pig-iron at the level of the melting zone.

The coke bed was charged in two portions, the first to a point just under the tuyeres, and when this part became thoroughly ignited, which might take two to three hours according to the diameter of the cupola, the balance of the coke bed was then charged, bringing the bed up to the level of the melting zone. The melting zone varied in some cupolas from about 12 to 24 in. above the tuyeres.

The amount of the charges was next considered. It was stated that an average charge of iron was equal to 1½ lbs. of iron per sq. in. of area in a cross section taken through the melting zone, and that the average charge of coke was one-tenth, and the charge of limestone one-fiftieth the weight of the charge of iron.

The question of the melting capacity of cupolas was next considered. The melting capacity of a cupola depended upon three factors, namely, the diameter of the cupola, the volume of air passed into it, and the pressure at which the air entered the cupola, and any formula which did not take each of these factors into consideration was not to be relied upon.

The lecturer stated that he had a difficulty in presenting this part of the subject, because of the fact that very few cupola installations embraced apparatus for measuring the quantity of air entering the cupola, and this was a defect which he would like to see rectified, because until there was the means of determining and regulating the volume of blast entering the cupola very little advance could be made in the study of cupola practice.

The next questions considered were the volume and the pressure of air necessary for cupolas, and arising out of these questions the subject of combustion was involved. The point which occurred to the observer in studying the cupola was the vast amount of difference between the theoretical heat values which should be obtained, and the heat values which were actually obtained in practice.

The number of British thermal units required to raise 1 lb. of iron to melting temperature and thereafter completely melt it was 504, therefore the B.Th.U. required to melt a ton of iron should be 2,240 × 504 = 1,128,960.

It was known that the theoretical value of 1 lb. of coke (90 per cent. carbon), if completely burned to CO_2 gas, should produce 13,086 B.Th.U. From these figures could be determined that the theoretical amount of coke required to melt 1 ton of iron was 86 lbs., whereas in actual practice the average amount of coke required to melt 1 ton of iron was about 224 lbs.

The lecturer then gave some consideration to the question of tuyere area, and the sectional area of the blast main in relation thereto. An example was given showing the method of determining by calculation the approximate chemical composition of the metal when several brands were mixed together.

A vote of thanks to the lecturer brought the meeting to a close.

NEWCASTLE BRANCH.

At a meeting of the Newcastle Branch on November 24, a discussion took place on several topical problems associated with the foundry trade generally. The President of the Branch, Mr. W. Mathews, occupied the chair.

At the outset the President moved a vote of condolence with a Past-President, Mr. Matthew Gallon, in the death of his son, Private J. W. Gallon, in Palestine. Private Gallon was an esteemed associate member of the Branch, and prior to joining the ranks of the British Infantry had seen much service with the Army Service Corps. A vote of sympathy with his parents was carried in silence, the members upstanding.

The Secretary (Mr. H. A. J. Rang) next read letters and telegrams from the King, the Prime Minister, the First Lord of the Admiralty, and the Secretary of State for War, acknowledging the messages recently forwarded on behalf of the Branch, expressing unswerving loyalty to the Throne, and whole-hearted support in the Government's determination to carry on until the common enemy of mankind and civilisation had been finally and effectually crushed.

The Value of Scrap.

The first question down for discussion was:—"What properties are possessed by scrap iron that cause foundrymen to use as much as 50 per cent. of it in their mixtures, and regard it as indispensable?"

The author of the question, Mr. Young, analytical chemist of Wallsend, opened the discussion, and observed that the rule-of-thumb mixtures generally contained 50 per cent. of scrap iron, and the other half was composed of pig-iron. If 50 per cent. of the cheapest material which could be got were used, then why should so much be paid for the other half? Founders often used a lot of very expensive pig-iron. So far as he had observed these things, the foundrymen put everything down to scrap. To the foundryman scrap

was like the wooden image to the heathen—if he got a good casting it was due to the scrap, and if he got a bad casting it was also due to the scrap. If the metal were re-melted there resulted a metal that was harder, and to a large extent the hardness was due to more sulphur. That went to show that scrap contained more sulphur than did pig-iron. What was it in scrap that gave that result? Suppose scrap were more expensive than pig-iron, would founders still use 50 per cent. of scrap? That was a question to which he had not yet found an answer. Personally, he could do without scrap if he wanted to.

Mr. Edward Smith said he could assure Mr. Young and the members that scrap to-day was dearer than pig-iron, and still they were using it. He was of opinion that they got a clearer iron with the 50 per cent. of scrap. He found the metal not so fluid if he did not use 50 per cent. of scrap; it was more sluggish, and whenever they had been short of scrap they had found that difficulty. The metal did not keep lively nearly so long when they had nothing but pig in it. What the property in the scrap was he could not tell.

Mr. W. J. Paulin, the ex-President, said he hardly agreed with what Mr. Young had said about scrap. He seemed to speak of scrap as though it were a glorified dross. There were different kinds of scrap. Unless founders could have everything analysed they felt safer in the knowledge that the iron now being broken up into scrap had been through the mill and had stood the test of time. Anybody who knew the use to which the scrap had been put in its working days could select it with the sure knowledge that it was good, because of the value attaching to the mixture when it was first made. That was one of the reasons why they relied so much upon good scrap.

Mr. Weir expressed the opinion that they could get fluid iron without resorting to scrap at all.

Mr. Young, replying to the discussion, said that a good cylinder did not necessarily make good scrap. The result depended entirely upon the pig-irons they were using to mix with it. They could bring a rotten scrap up to be quite a good casting by using good pig-iron. It largely depended upon the mixture.

The Value of Flux.

Mr. Young next raised the question:—What is the value of a flux to a brass foundry? He said that the majority of brass foundries used no flux at all, and yet they talked about fluxes as though they did use them. Having given analyses of some fluxes, he went on to say that some were used to protect the surface of the metal. Some of them were supposed to get the impurities out of the metal. But no brass foundry seemed to use those things, in spite of the fact that advertisements for fluxes were always being published. Somebody sold them and somebody must buy them. He had brought with him one or two pamphlets setting forth the claims for fluxes. Amongst other things it was claimed for one that it would make the metal run more rapidly. For another it was claimed that "it effects a great saving in tin where high pressure is necessary." Another said that "it gives strength to the metal without hardness, so that the life of tools is protected and great saving effected." "Foundrymen can save 2 to 2½ per cent. in cost by using this flux," said another. Now, if all those things were true, they ought to be using fluxes. Somebody must be buying fluxes, and he would like to know if they were proving any good; if not then those who bought them were simply throwing away their money.

Improvement of Surface of Castings.

The third question introduced was:—"In view of coming foreign competition is it not important that the surface appearance of our castings should be improved without putting up the cost? If so, what is the state of our knowledge upon this subject, and what steps can be taken to extend it?"

The President, in a brief introduction to the subject, pointed out that castings from different districts had different appearances. The castings from the Midlands, for instance, had usually a better appearance than the castings made on the North-East Coast, and that was attributed to the particular moulding sands they employed. The sand mixtures used in the North were not considered the best for improving the surface of the casting.

Mr. Henderson said that for his part he had never seen any castings made on the North-East Coast equal to the Scottish and Midland castings. One of the things that militated against them in the North was that there was such a variety and very little standardisation. It was difficult in the North to get sand mixtures standardised owing to the variety. His experience had driven him to think that the superiority of Scottish and Midland castings was due to the iron. The Scotch and Midland irons had a tendency to take on a closer skin than the Middlesbrough iron; and temperature had possibly also something to do with it. Middlesbrough iron seemed to come white out of the furnace, and the Lincolnshire or Scotch irons, although they seemed to be "done up," still ran, and with a percentage of those irons in the metal he was sure he got a better skin on the castings.

Mr. Edward Smith observed that the Scotch people, singularly enough, did not use Scotch irons. They used far more Middlesbrough iron than Scotch. He thought they could not get any better skin on the castings unless they had better moulding. He thought the moulder had more to do with it than anybody else. He would like to know why some men would use a material and get the skin first class, and other men using the same material would get the skin ragged and pimply. He thought that it was the fault of the moulder if there was a bad skin on the casting.

A Member asked if it were not advisable to let every man mix his own sand. He thought if they did not they would find that some men would have better castings than others. Sometimes the sand was not properly separated unless they had a sand-mixing machine, and if the sand was more worked—not milled—but worked so as to grind those pieces up, they would get better castings. At his place they had a centrifugal sand mixer, but it did not eliminate the bad properties for the green-sand castings.

The President thought that some moulders were addicted to too much sleeking, and they thus destroyed the surface of the metal by not allowing the free egress of the gas in the sleeking process. It was largely a question of the manipulation of the sand.

Mr. E. Smith said there was a very good axiom:—"Never sleek twice when once will do."

Another Member said that North-country sand was too close. If they wanted it properly mixed they had to mix it themselves.

Women in German Foundries.

A recent foundry number of "Stahl und Eisen" contains an article by Herr Kurt Abeking on the experience gained with women in munition works in Germany, especially in foundries. Before the war the suggestion of employing women in rolling mills, steel works and ironfoundries would have been ridiculed; now it is an accomplished fact. About three months is stated to be the minimum time required for training a female to

FIG. 1.—WOMEN POURING METAL.

become a fully-qualified artisan. This, however, only applies to repeat work, and a much longer term must be allowed for training in other kinds of work. It is of special importance to choose the candidates with great care, and the author's experience has convinced him that the usual way of deputing an old workman or workwoman to teach a new-comer is but a slow method and leads to many failures. Turning one of the foremen into a teacher of females, too, often ends in a failure, as the teacher may not be able to impart his knowledge and skill to his pupils, especially to those who are less good-looking than others! A frequent fault of such instructors is that they freely use technical terms and interlard their explanations with expressions which are more likely to confuse than to enlighten their pupils. The author's plan has therefore been to choose specially qualified instructors from among the women who had been employed in munition work for some time, and promote them in due course to forewomen. In order to make them more generally useful as instructors, they are given opportunities to make themselves thoroughly proficient in different departments of the foundry, including making cores, fettling work and work with different kinds of moulding machines. The results of this system have been satisfactory, as the female apprentices treat their women instructors with greater deference than they would men, and women who themselves have only quite recently been initiated into the mysteries of the craft seem to have a better knack to teach their sister-workers than men who have grown up and spent all their lives in the foundry or workshop. It should also be borne in mind that in many cases the female munition workers are drawn from the more educated and more intelligent lower middle classes, while the foreman, as a rule, belongs to the working classes. These women, moreover, seem to be more conscientious in the fulfilment of their duties than their brothers or sisters of a lower social order.

The question was recently raised whether it would be advisable to arrange special lectures for prospective women workers, and to draft hands from such training schools into the various works, but the general opinion was against the scheme, owing to the great variety of work that would have to be taught to apprentices.

From replies received to his inquiries and from his own personal experience, the writer of the article has arrived at the conclusion that, generally speaking, the output of a trained female is equal to from two-thirds to three-quarters of that of a trained male worker. There have been exceptions, he says, where women have turned out as much work as men. An important factor in female efficiency is suitable clothing—trousers, jacket and cap—the cost of which need not exceed 7s. 6d. to 10s., for which small sum a serviceable suit can be obtained. After exchanging her usual attire for more suitable clothing, the workwoman will tackle her job with greater ease and alacrity than before. The author publishes some photographs showing women engaged in different parts of the foundry, of which we reproduce one showing two women pouring metal (Fig. 1), another representing five women formed into a gang and being taught moulders' work (Fig. 2), and a third showing women sorting and cleaning castings (Fig. 3).

The possibility of employing women in foundry work may be said to be almost unlimited. Men will, of course, always be preferred in making heavy castings and attending to the cupola, but in all other parts of the foundry women can be and are being employed. They have acquired great skill in hand moulding in all its branches, and as

FIG. 2.—GROUP OF FIVE WOMEN TRAINING.

regards machine moulding their employment is only limited by the weight of the moulding boxes that have to be handled and the lifting appliances at hand.

Women were employed even before the war in making cores, and with the introduction of making shells of cast metal women found their way into almost every foundry for making cores. It was doubted at first whether they would be able to ram

uniformly the cores of large shells, but they have performed this work so satisfactorily that they have supplanted the male workers entirely in some foundries in this special branch. Indeed, it was found that the women's output was much better in quality and double that of men in quantity for the same number of working hours. Women will be more and more employed in making cores for larger castings, especially loam cores on barrels to templates, in which kind of work new-comers soon acquire great proficiency. But even in the case of more complicated sand cores, not excepting green-sand cores for small castings for sewing machines, electric motors and the like, women very quickly outrival both in quantity and quality youths of 17 or 18 who are in normal times employed on this kind of work.

A great obstacle to extension of female labour is the obstinacy of old foremen, who are prejudiced against, and treat with contempt, female labour. It is in this respect that skilled forewomen prove of advantage. Besides, it is always advisable to group female workers together under the

FIG. 3.—WOMEN AT THE GRINDSTONE AND SORTING CASTINGS.

supervision of one of their own sex rather than to employ them separately.

Women can also be usefully employed in the fettling shop, in cleaning, dressing and grinding castings, working the sand-blast, at the grindstone, etc. The constant rattle, noise and dust, of course, require a strong constitution, and women have to be selected specially for these jobs, especially for work at the grindstone. Taking, however, everything into consideration, women will be more usefully employed as moulders. They are more reliable, more intelligent, and harder workers than the common run of youths, besides which their fingers are more nimble, and they have a finer touch than males. In the pattern-shop, however, their employment will always be more limited and more or less restricted to secondary work, like cleaning, painting, varnishing, etc., patterns. In these subordinate branches they make thoroughly reliable workers. They are employed also occasionally as crane-drivers, especially with electric cranes.

The author of the article then gives statistical data as regards the percentages of the workers in a foundry which, in June, 1914, employed 500 people, all males. Of these 28 per cent. were trained men, 53 per cent. unskilled men, and 19 per cent. were youths. The same foundry now employs about 600 people, of whom 15 per cent. are trained men, 34 per cent. unskilled men, 29 per cent. are youths, and 22 per cent. are females. It must be noted, however, that the foundry in question turns out, almost exclusively, high-priced special castings, for the making of which none but expert workers with special training of several years can be employed. Other foundries turning out merely ordinary castings would no doubt be able to employ a higher percentage of female and unskilled labour. Thus even in the foundry referred to the percentages in the munition department are as follows:—6 per cent. trained men, 26 per cent. unskilled men, 20 per cent. youths, and 48 per cent. women.

One important point in employing female labour is the question of rate of pay. Some of the trade unions advocate that the women's rate of pay should be fixed at one-third less than that paid to men. This may be feasible in some works, but it would be rather difficult to adopt it in a foundry. The author's plan has been to pay for piecework at the same rate whether the work is done by men or women, unless the latter require extra help men could do without, in which case, however, the women always agree to a slight reduction in wages to pay for the assistance they receive. Women, besides, seem to prefer work in the machinery shop to work in a foundry, and have to be attracted there by better wages.

PROPOSED IMPERIAL BANK OF INDUSTRY.—An important report has been issued by the Committee on Banking of the British Empire Producers' Organisation recommending a scheme, the main feature of which is to afford readier financial support on sound principles throughout the United Kingdom and the Oversea Dominions and Colonies for producers and manufacturers. The available capital is to be provided in the shape of debentures and deposits with State guarantee. Further capital will also be accumulated by the funding of profits, as apart from a small bonus to debenture holders and depositors all surplus will remain in the bank. Provision is made for government by boards of trustees, on which both employers and employed would be represented. The guarantee capital is estimated at fifty millions sterling (to be enlarged as demand shall arise), the amounts suggested for the guarantors being as follows:—United Kingdom, £25,000,000; Dominion of Canada, £6,000,000; Commonwealth of Australia, £6,000,000; Dominion of New Zealand, £2,000,000; Union of South Africa £2,000,000; Newfoundland, £1,000,000; Straits Settlements and Malaya, Ceylon, British Guiana, Mauritus, West Indies, Rhodesia, Falkland Islands, Fiji, and other British Possessions, £8,000,000. Among the objects of the scheme are:—To strengthen and to extend producing and manufacturing industries already established in the Empire; to assist in the foundation and development of new industries therein; to assist by credit facilities in the sale of their products. These objects it is proposed to achieve by making advances by way of cash credits against such security or guarantee as the trustees shall deem sufficient; accepting drafts made against shipments or deliveries of industrial products or of materials; buying and selling bills of exchange against collateral security; issuing letters of credit; discounting trade bills; purchasing secured time payment accounts or by advances upon the same; assisting and co-operating with other financial institutions in underwriting the share and debenture issues of present or future industrial undertakings; collecting and collating information likely to be useful to its customers.

Metal-Pouring Device.

In a recent issue of "The Iron Trade Review" was described a buggy ladle which is now being used in a number of American and Canadian plants. The device was designed by Mr. Max Trembour, Ludlum Steel Company, and Mr. T. W. Price, consulting engineer, New York. At the Ludlum steel plant, where the device was first placed in service, the labour-cost of pouring metal has been reduced two-thirds by the use of this buggy ladle.

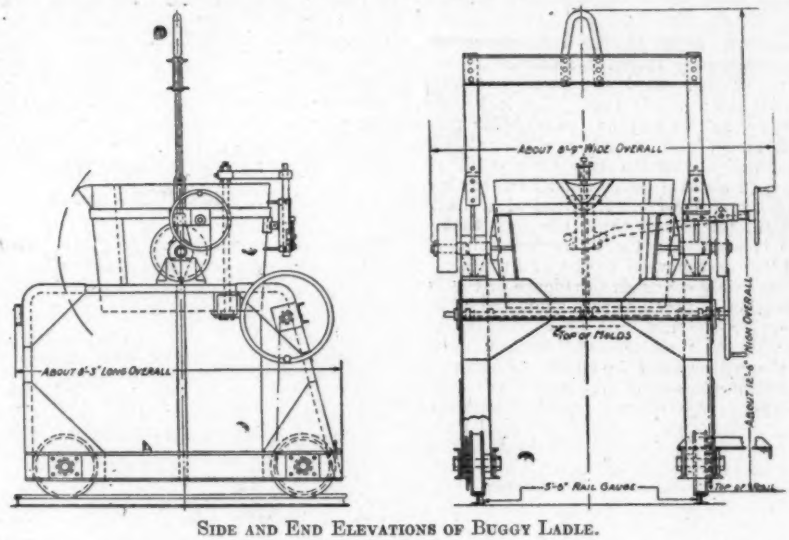
The details of the ladle are shown in the accompanying illustrations. The device consists essentially of a framework supported on four wheels which operate on rails. The moulds to be poured are placed between the tracks. The ladle is supported on the framework. One operator, standing on a platform at the side, with one hand controls the pouring by means of a lever, and with the other hand propels the buggy forward or backward, as desired, through a hand-wheel. The ladle can be tilted by means of another hand-wheel.

The ladle may be brought to the truck by a crane after the furnace is tapped, or the tracks may be extended to the furnace, and the metal tapped directly into the ladle as it rests on the buggy. Four-sided pyramid castings are provided at each side of the bale ladles. These castings engage with openings in castings on the truck so that as the ladle is lowered it automatically seats itself on the ladle truck. The position of the bottom-pour spout is thus brought directly into line with the moulds.

One labourer, standing on the platform, can tip the ladle by means of self-locking gearing actuated through a hand-wheel, can control the bottom spout pouring device through a lever, and can move the truck along its tracks by means of a chain drive. Roller bearings are employed to facilitate the movement of the truck. The operator, when turning the wheel with one hand, can propel the truck and loaded ladle about 50 ft. per minute.

The operator is completely protected from any molten metal which may be spilled, as the side plate of the truck is between him and the metal. A peep hole, covered with mica, is provided in one of the side plates. Through this hole he can see the bottom of the pouring spout and the top of the mould. The device is operated solely by hand, no electricity being used.

The problem of centreing the bottom-pour spout over the mould is said to be simplified by the ease with which the operator can move the truck in either direction. Any wastage of metal in filling the mould can be avoided, as the operator can check the flow immediately when he sees that the mould is filled. The device is the subject of a patent application.



SIDE AND END ELEVATIONS OF BUGGY LADLE.

THE THERMAL AND ELECTRIC CONDUCTIVITIES OF CARBON STEELS.—Professor Dr. Carl Benedicks in 1902 proposed a numerical relation between the electric resistance of steels and their composition, his equation being based on his own experiments, and expressing the conductivity as a function of the sum of percentages of dissolved carbon plus the sum of equivalent "carbon values" of all the other dissolved elements. His equation has been accepted, within certain limits, by other writers. But as regards the thermal conductivity of carbon steels in connection with their composition, according to Mr. Takéo Simidu, a Japanese author, there appear to be hardly any accounts published. He has therefore set to work and has made investigations to ascertain in what manner the amount of dissolved elements, especially carbon, affect the thermal conductivity of steels. The method and results of his investigation are published in the latest issue of the "Science Reports" of the Tohoku University, to hand. The thermal conductivity of steels, according to him, varies in the same manner as the electric conductivity, and he gives three equations to calculate it for forged, or annealed, or quenched steel, as the case may be. In a comparative table (5) he gives the calculated and observed values for a dozen specimens of Krupp carbon steels for each of the three treatments and the discrepancies between theoreticals and actuals only range between +0.008 and −0.0012 gr. cal. per deg. cm. sec. Another table (6) gives the ratios of the two conductivities or the product of the thermal conductivity and the electric resistance.

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Electrometallurgy in France.

Dr. C. O. Mailloux, who was a member of the American Industrial Commission to France, has published a long report on "Hydro-electric Power and Electrochemistry and Electrometallurgy in France," from which the following extracts are taken.

Dealing with the cost of electric power the author points out that the question of prohibitive cost differs according to the purpose and the process for which electrical energy is needed. In the case of metallurgical or chemical processes involving the use of electric furnaces or depending upon the heating effects produced by electric currents, the cost of electric current ought to be brought down to about £2 10s. per electrical horse-power per year (which is equivalent to about £3 6s. 8d. per kilowatt-year), and it is highly desirable that the cost should be as much below that figure as possible. It is said that in the case of some of the large water powers in Norway, where the cost of development per horse-power was very low, the cost of power at the power station is as low as about £1 1s. or £1 5s. per horse-power-year. These are exceptionally favourable cases. A power cost of £2 to £2 10s. per horse-power-year would be considered low; above that price it becomes less satisfactory, and it may be too high for many purposes. A cost of £3 6s. 8d. per kilowatt-year (8,760 hours) corresponds to less than 0.1d. per kilowatt-hour. If electric power must be very cheap in order to be useful for electrochemical and electrometallurgical purposes, then the fact that so much power is used for these purposes in the "white coal" (water power) region of France may be regarded as fairly conclusive evidence of the low cost of production of that power. From the official figures given for the different uses made of the water power in the "white coal" region, it appears that the power used in electrometallurgical works (255,000 h.p.) and that used in electrochemical works (147,000 h.p.) together make up 402,000 h.p., or 54.5 per cent. of the total power in that region. It may be fairly presumed from the physical characteristics of the "white coal" region that the undeveloped power in that region will not prove more expensive than that which is already in use. Moreover, the possibilities of cheap power in the region of the Pyrenees are also very good. It is quite conceivable, therefore, that there may be available in France an amount of very cheap hydro-electric power suitable and economical for electrochemical and electrometallurgical work that would, in time, bring the aggregate of such work to a point requiring as much as 1,500,000 or even 2,000,000 h.p. When that time arrives France will be occupying a position of highest importance in these industries.

In the region of the Alps almost 35 per cent. of the aggregate hydraulic power is utilised in electrometallurgical work. The only industry utilising more hydro-electric power is that of "lighting and power," which utilises 38.4 per cent. of the whole amount.

Aluminium.—It was this metal which gave France an opening for entering the field of electrometallurgy. The subjoined table gives the relative production capacities of different countries two or three years before the war, and shows that France led the world, with a production capacity equal to 39.2 per cent. of the total. Of the ten French aluminium plants, the nine in the region of the Alps represent an aggregate of 120,000 h.p.; the other is in Southern France. It is interesting to note that from 1886 to 1896 it was Switzerland and not France that led the world in production capacity of aluminium. Its production capacity, after that time, remained nearly stationary, while that of France continued to increase. One important reason why France attained a leading position was the fact that, at first, and until recent years, practically all the bauxite used for making aluminium came from France. The French bauxite is generally considered superior in quality to that from any other source. In spite of her great advantages, however, France has not retained the leading position. With a domestic consumption of only about 3,000 tons, and a production capacity of 19,000 tons per year, there is a large surplus which must depend on finding a market abroad.

Production Capacity for Aluminium.

Country	Number of concerns	Number of plants.	Aggregate H.P.	Capacity in tons per year.	Per cent of total.
France	6	10	140,000	19,000	39.2
United States ..	3	3	105,000	12,500	25.8
Canada	1	1	20,000	2,500	5.2
Switzerland ..	1	2	27,000	6,000	12.4
Germany ..	1	1	5,000	600	1.2
Austria	1	1	5,000	800	1.6
England ..	2	2	21,000	3,800	7.8
Norway	2	2	21,000	2,100	4.3
Italy	2	2	4,000	1,200	2.5
Total	19	24	348,000	48,500	100.00

Electro-siderurgy—The Commission had the privilege of visiting one of the largest "electro-siderurgical" plants in France, the works of the Compagnie des Forges et Aciéries Electriques Paul Girod, and the works of the Société Electro-Métallurgique Procédés Paul Girod, which are affiliated establishments, at Ugine, in Savoy (in the "white coal" region).

The first of these establishments is equipped for making electric steel castings up to 25 tons. The six furnaces that were in operation have an aggregate charge capacity of 35 tons. Two more furnaces were under construction, one of 2 tons, and one of 12 tons, which will make the aggregate charge capacity 47 tons. Each furnace can be used for making at least three heats per day, and each heat requires about 6½ hours. With the six furnaces already in use there was no difficulty in making 3,000 tons of electric steel per month, or an average of 100 tons per day.

Ferro-Alloys.—There is, perhaps, no application of the electric furnace in which it has been more successful than in the manufacture of "ferro-alloys." France has played a leading part in the erection of this new branch of electrometallurgy. There were in France before the war no less than 13 concerns engaged in this new electrometallurgical industry. One of these is the works of the Société Electrometallurgique Procédés Paul Girod, at Ugine, Savoy, adjoining the steelworks already mentioned. This plant is one of the largest producers of ferro-alloys and rare metals in the world. It is a large producer of tool steels and of so-called "rapid steels." The total production of ferro-alloys in France in 1910 was 64,000 tons, of which a little less than half was made in electric furnaces. Since then the production by the electric furnace has been enormously increased.

The Workington Steel, Peech and Tozer Amalgamation.

The following circular, signed by Sir J. S. Randles, the chairman, has been issued to the shareholders of the Workington Iron & Steel Company, Limited :—

At the last shareholders' meeting I indicated that negotiations for certain amalgamations had been under consideration, but there was nothing definite to place before the shareholders. I am able to inform you that arrangements have now provisionally been made for the combination and amalgamation of the several companies of: Steel, Peech & Tozer, Limited; Samuel Fox & Company, Limited; the Frodingham Iron & Steel Company, Limited; and the Workington Iron & Steel Company, Limited. Under the scheme it is proposed to form a new company to take over and acquire the entire assets and undertakings of the several companies. Application is in course of being made to the Treasury for its consent to the scheme, and at the earliest opportunity the arrangements will be submitted to the shareholders for confirmation in general meeting, when the full details will be placed before them.

Recent mention has been made of the amalgamation between Steel, Peech and Tozer and the Frodingham Company. Without the Workington Company the estimated output of the amalgamation was in the neighbourhood of 1,000,000 tons of ingots a year. By the inclusion of the Workington Company the combined firms secure an ample supply of raw materials for the acid process of steel making, just as the inclusion of the Frodingham works gave them control of a supply of low-grade basic ore. The Workington Company have made very considerable extensions recently, and have built a large acid open-hearth plant, so that the total capacity of the combine in ingots will be well over 1,250,000 tons per annum, but as regards output much depends upon what use is made of the extensive Bessemer steel plant which the Workington Company possess. In some cases making steel by this process has been compulsorily stopped.

Further Control of Timber.

The Board of Trade announce two Orders under the Defence of the Realm Acts. The first, as published in a recent "Gazette," fixes maximum prices for home-grown timber at all stages from the standing tree to the plank, and the second prohibits the export of native timber from Ireland without a permit, for which application must be made to the Assistant Controller of Timber Supplies (Ireland), 6, Hume Street, Dublin.

It is emphasised that as regards standing timber the maximum prices are intended to apply to timber of the best quality in the most accessible positions. Prices for other timber should be based upon the maximum rates, having regard to the usual factors of quality, accessibility, haulage, and other conditions.

The maximum prices per cubic foot fixed by the Order for standing trees are: Larch, 1s. 4d.; Scots pine and Douglas fir, 11d.; spruce and other firs, 10d.; ash selected for aeroplane purposes, 5s.; ash for other purposes, 3s.; ash of inferior descriptions, 1s. 6d.; oak, well grown selected trees, 3s. 3d.; oak, well grown whole parcels, 2s. 3d.; oak of inferior descriptions, 1s. 3d.; sycamore and hornbeam, 2s.; Spanish chestnut, 1s.; selected trees, 2s.; beech, 1s. 6d.; poplar, alder, and lime, 1s. 3d.; elm, 1s.; and other common hardwoods, 1s. For timber felled and trimmed lying in the wood these prices may be increased up to 10 per cent.

The Order also fixes maximum prices for timber in the round, sawn, or converted, and cancels the Home Grown Timber Prices (Great Britain) Order of July 4 last, which dealt only with certain sizes of converted home-grown softwood.

Trade After the War.

The Lords Commissioners of his Majesty's Treasury and the Minister of Reconstruction have appointed a committee, with the following terms of reference :—

To consider and report whether the normal arrangements for the provision of financial facilities for trade by means of existing banking and other financial institutions will be adequate to meet the needs of British industry during the period immediately following the termination of the war, and, if not, by what emergency arrangement they should be supplemented, regard being had in particular to the special assistance which may be necessary :—

(a) To facilitate the conversion of works and factories now engaged upon war work to normal production.

(b) To meet the exceptional demands for raw materials arising from the depletion of stocks.

Applications for Patents.

Alldays & Onions Pneumatic Engineering Company, Nicholson, A., and Hodkinson, H. Operating mechanism of tilting crucible furnaces, etc. 17,660. November 29.

American Die Casting Company. Moulds for casting metal. 16,731. November 14. (United States, February 9.)

Ames, F. T. Casting or moulding apparatus. 17,712. November 30.

Barnsley, F. H., and Everitt & Sons, A. Making castings or ingots for production of condenser tubes, etc., by drawing. 17,805. December 1.

Brookfield, D., Gaunt, J., and Tyler & Song, J. Smelting furnaces, etc. 17,367. November 24.

Brown, G. Apparatus for testing hardness of metals. 17,231. November 22.

Brown & Company, J., and Grant, G. C. Nozzles, etc., for pouring or teeming molten metals. 16,648. November 13

Burn, H. S., and Hoyle, J. R. Annealing, tempering, or heat-treatment furnaces for metals. 17,931. December 4.

Chattaway, D. Machine for testing hardness of metals. 18,215. December 8.

Dear, C., and Miris Steel Company. Alloy steels. 18,055. December 5.

Deutsch-Luxemburgische Bergwerks-und Hütten-Akt.-Ges, and Waldmann, S. J. Process of briquetting iron and steel scrap. 16,681. November 13.

Dickson, H. C. Plant for quenching, hardening, tempering, etc., steel, etc. 17,793. December 1.

Gains, J. Electric furnaces. 17,700. November 30.

General Electric Company. Alloys. 17,095. November 20.

Greenhill, C. B. Method of cooling-off castings. 17,848. December 3.

Hall, A., and Moody, F. Electric furnaces. 17,700. November 30.

Harvey, L. C., and Morgan Crucible Company. Crucible melting furnaces heated by gas or oil. 17,302. 17,303. November 23.

Honda, K. Magnet steel. 16819. 16820. 16821. November 15.

Hughes, T. V. Treatment of metals and alloys. 17,248. November 23.

Hutchins, T. W. S. Muffle furnaces. 16,965. November 17.

Ionides, A. C. Melting-furnaces. 16,807. November 15.

Kane, W., and Richards, E. J. W. Gas and air reversing valves for steel-melting, etc., furnaces. 17,843. December 3.

Kane, W., and Richards, E. J. W. Heating, annealing, welding, etc., furnaces. 17,844. December 3.

McGregor Brothers and McGregor, R. Moulding machines. 18,077. December 6.

Needham, J. B. Moulding-machines for foundry use. 16,966. November 17.

Oxley, G. H., and Oxley & Sons, G. Apparatus for casting clusters or groups of metal ingots. 18,126. December 7.

Reid Brothers. Apparatus for testing hardness of metals 17,231. November 22.

Robinson, J. A. Tool steel. 17,201. November 22.

Sellers, J. C. Manufacture and treatment of steel. 17,243. November 22.

Sutcliffe, E. R. Furnaces. 17,372. November 24.

Walker, J. B. Ingot-mould flasks. 16,716. November 14. (United States, December 13, '16.)

Wellman, Seaver & Head, and Smith, F. G. Steel-making furnaces or mixers, etc. 16,585. November 12.

Trade Talk.

THE engineering works of Messrs. J. Holroyd & Son, Rochdale, have been seriously damaged by fire.

THE merchants of Sheffield have formed a merchant section of the Sheffield Chamber of Commerce.

JOHN WILLIAMS AND SONS (CARDIFF), LIMITED, have removed to Globe Warehouses, East Moors Road, Cardiff.

A WINDING-UP order has been made against the International Metal Company, Limited, 1 and 2, Bucklersbury, London, E.C.

THE BRITISH HIGH POWER GAS ENGINE COMPANY, LIMITED, is being wound up voluntarily, with Mr. F. G. Palin as liquidator.

A SMALL fire broke out at the works of Mr. A. Richardson, iron and brass founder, Mansfield, recently, but very little damage was done.

CONSIDERABLE damage has been caused by a fire at the Sheffield works of A. Spafford & Company, Limited, tool and file manufacturers.

Mr. A. Hodgkinson, 22, Queen Street, E.C., has been appointed receiver of the Thames Iron Works, Shipbuilding and Engineering Company, Limited.

BURTON, GRIFFITHS & COMPANY, LIMITED, Ludgate Square, Ludgate Hill, E.C.4, have established a branch at Central House, New Street, Birmingham.

MESSRS. J. AMATT & T. A. DOLAN, carrying on business as the Witton Engineering Company, 27, Newtown Row, Birmingham, have dissolved partnership.

MESSRS. THOMAS TURNBULL & SON, of Whitby, have disposed of their Whitehall shipbuilding yard by private treaty. The yard, which has space for five or six ships, has been closed since 1902.

A FIRE occurred last month in the North British Steel Foundry, Bathgate, doing considerable damage to the building containing the pattern shop, woodwork shop, laboratory, and time office.

THE shareholders of National Alloys, Limited, have decided to wind up the company voluntarily. Mr. A. Hodgkinson, 22, Queen Street, Cheapside, London, E.C., has been appointed liquidator.

MR. HAYES FISHER has issued a circular to local authorities with regard to the urgent need for a systematic collection of metal scrap, especially iron, steel, lead, copper, brass, and aluminium.

IT is officially ordered that no person or company shall sell or supply oxygen other than to such persons and in such quantities as the Director of Materials and Priority shall from time to time direct.

THE partnership heretofore subsisting between Messrs. F. H. Rigby and S. H. Smith, carrying on business as metal merchants, at Bishop Street, Birmingham, under the style of Smith & Rigby, has been dissolved

AT a meeting of the West of Scotland Iron and Steel Institute, held in the Royal Technical College, Glasgow, Mr. O. C. Beale read a paper on "Our Imperial Strength, Based on the Metal Industries and an Efficient Banking System."

MESSRS. W. PILKINGTON, the younger, and T. Powell, casters, 265, Dartmouth Street, Birmingham, trading under the style of T. Powell & Co., and at Farm Street, Hockley, Birmingham, under the style of the Residuals Company, have dissolved partnership.

IT is reported from Glasgow that Charles Connell & Company, Limited, Scotstoun Shipbuilding Yard, Whiteinch, Glasgow, the Ayrshire Dockyard Company, Limited, Irvine and Dunsmuir & Jackson, Limited, Govan Engine Works, Glasgow, have combined.

The partnership heretofore subsisting between Messrs. J. B. Adrien, E. Peranne, A. Aube, and J. Vreeken, carrying on business as press tool makers, at 223 and 225, Pentonville Road, London, N., under the style of the Press Tool Company, has been dissolved.

THE ADMIRALTY have decided, we understand, not to proceed with the construction of a fourth national shipyard. In view of the tour of Bristol Channel sites made by representatives of the Admiralty, it is probable that one or other of the sites offered there may be utilised for ship-repairing.

THE old premises at Chiswick of John I. Thornycroft & Company, Limited, have been sold and the proceeds expended on the purchase of the freehold of the Southampton works. Large extensions to buildings and plant have been made without financial assistance from the Government or other sources.

MR. JAMES MARSHALL, of Marshall, Sons & Company, Limited, engineers, of Gainsborough, states that he is proposing to apply to the Board of Trade for powers to provide not merely further electricity for his own firm, but to supply current for public and private use within the urban area of Gainsborough.

THE London offices of the Anglo-Mexican Petroleum Company, Limited, the Eagle Oil Transport Company, Limited, Highways Construction, Limited, and the Bowring Petroleum Company, Limited (Kerosene and Spirit Department), have been transferred from Finsbury Court to 16, Finsbury Circus, E.C.2.

We understand that the Ministry of Munitions have under consideration the fixing, at an early date, of maximum prices for cast-iron scrap and also for second-hand rails weighing under 50 lbs. per yard. A maximum price is already in operation for rails of greater weight, and it is intended, we believe, to fix one for the lighter variety.

AT a meeting of members of the Patents, Trade Marks, and Designs Section of the London Chamber of Commerce the terms of the Government Bills to amend (*a*) the Patents and Designs Act, 1907; and (*b*) the Trade Marks Act, 1905, were considered, and committees were appointed to take action to secure certain necessary amendments in both measures.

THE capital expenditure of the Blaenavon Company, Limited, during the past year has been chiefly on steel works and blast-furnace extensions, completion of new coal washery and water softening plants, and improved railway sidings. Part of the steel works extensions has been completed since September 30, and the whole of this section should be in commission in a few months' time.

AT the annual meeting of the Sheffield Society of Engineers and Metallurgists, held recently, the members re-elected Professor Arnold as president for the ensuing year. Mr. E. J. Thackeray, assistant secretary, was elected to succeed Mr. E. C. Ibbotson as honorary secretary. Mr. C. K. Everitt was re-elected treasurer. An interesting paper dealing with the subject of steel ingots was read by Mr. J. N. Kilby.

SIR JOHN HARMOOD-BANNER asked the President of the Board of Trade whether any arrangements had yet been arrived at in this country to deal with the Australian concentrates. SIR ALBERT STANLEY, in reply, stated that arrangements had already been made for the treatment of a quantity of the Australian zinc concentrates at works to be erected at Avonmouth, and negotiations for the treatment of further quantities at Widnes and possibly elsewhere were in progress; but no suggestion for this treatment in Norway had been made in any quarter.

WITH a view to centralising their business in London the Stanton Ironworks Company, Limited, have opened an office at Maxwell House, Arundel Street, Strand, W.C.2, and matters relating to their coal and cast-iron foundry business will be dealt with at this office. The foundry agency arrangement which has existed for many years past between the company and Beck & Company, Limited, is being terminated at the end of this year. Mr. Arnold Longden, who has represented the company for some years on the London Coal Exchange, will, during the period of the war, supervise the foundry section of the business in addition to the coal business.

THE MINISTER OF MUNITIONS has made the following appointments:— Sir Stephenson Kent (on return from the United States), to resume his duties as Mem-

ber of Council for the Labour (L) Group of Departments of the Ministry of Munitions; Major J. W. Hills, M.P., to be Member of Council (additional); Sir Charles Ellis, Member of Council for the Allies Group, to take charge of the Paris establishments of the Ministry of Munitions; Sir William Weir, Controller of Aeronautical Supplies, to be Director-General of Aircraft Production; Major-General G. T. M. Bridges to be Controller of the Trench Warfare Department of the Ministry of Munitions.

Following the death of Mr. Benjamin W. Head, managing director of Wellman, Seaver & Head, Limited, steelworks engineers, King's House, Kingsway, W.C., a rearrangement of the business has taken place. Mr. Fredk. I. Sanderson and Mr. Fredk. G. Smith have been elected joint managing directors, while Mr. Percy K. Stothert, of Stothert & Pitt, Limited, of Bath, has rejoined the board. Mr. S. T. Wellman continues as chairman. Of the two managing directors Mr. F. I. Sanderson has been the secretary since the formation of the company in 1905, and has been a director since 1914. Mr. F. G. Smith has been with the company since 1906, and was appointed chief engineer in 1910 and a director in 1916.

Mr. Bridgeman has informed Mr. Byrne that as regards the general position of apprentices in engineering and electrical firms, the matter should be dealt with by the Minister of Munitions. The general awards of the Committee on Production for the engineering and foundry trades affected directly only establishments belonging to the Engineering Employers' Federation. Under those awards the advances given to boys and apprentices under eighteen years of age had been :—(1) 2s. 6d. a week from April 1, 1917; (2) 1s. 6d. a week from August 1, 1917; (3) 2s. 6d. a week from the beginning of the first full pay in December, 1917. In the case of boys and apprentices over eighteen years of age the respective advances given as from the dates named were 5s., 3s., and 5s.

In November, 1910, the Harrington Ironworks were stopped after a successful run of over forty years. The brickyard, joiner's shop, blacksmith's shop, and a few of the fitters were continued, and the offices were reconverted into cottages. For a time the prospects of Harrington were not very bright, but gradually affairs settled down. With the development of the coal mines, brick works and by-product works at Lowca, every house was occupied, and to-day there are more tenants than houses. The ironworks, which belong to the Workington Iron and Steel Company, Limited, have been restarted, and the furnaces are now once more in blast after a thorough renovation. Mr. Jos. Wilkinson, who has had considerable experience, has been appointed resident manager, and Mr. Wilson continues as engineer.

Messrs. Harland & Wolff's scheme for the extensive enlargement of the shipbuilding yard of Messrs. Caird & Company, Greenock, has been advanced another stage. The trustees of the old West Church, of Greenock, who were formerly against the proposal, have now decided that, for their part, they will not oppose the scheme, provided the details are arranged to their satisfaction, and that they are willing to accept the offer of the firm to remove the old church as it stands to another site. The church and churchyard occupy ground to the south-west of Messrs. Caird & Company's present establishment, and its acquisition will give the firm a greatly increased length of building berth. The scheme provides for the taking in of an area covering, roughly, half a mile to the east of Messrs. Cairds' shipyard, and the conversion of the West Harbour into a fitting-out basin.

We understand that Dorman, Long & Company, Limited, of the Britannia Steel Works, Middlesbrough, and the Clarence Steel Works, Port Clarence, have acquired the whole undertaking of Sir Bernhard Samuelson & Co., Limited, Newport Ironworks, Coke Ovens and By-Product Works, Middlesbrough, comprising blast furnaces, coke ovens, collieries and ironstone mines. It was not very long ago that Messrs. Dorman, Long & Company took over the Redcar Ironworks of Walker, Maynard & Company, Limited, who owned six blast furnaces, and the Kilton Ironstone Mine at Brotton. The works of Sir B. Samuelson & Company comprise eight blast furnaces, of which six are in blast, two making hematite and four making forge and foundry, the other two being in course of rebuilding or relining. There are also 176 Otto coke ovens, and 70 of the Simon-Carves type. The company likewise own the Hedley Hope and East Hedley Hope Collieries at Tow Law, and the Spawood Iron Mines at Guisborough. The capital of Sir B. Samuelson & Company, Limited, who were registered as a limited liability concern in October, 1887, is £275,000 in £20 shares.

The following letter has been sent to the various Government Departments concerned, and also to the members of the Commercial Committee of the House of Commons :—"At a meeting of the Metal Merchants' Section of the London Chamber of Commerce, held on November 28, there was under consideration the report of the Advisory Committee of the Board of Trade on Commercial Intelligence, and especially the recommendation to the effect that public money should be expended to cover expenses incurred by Export Associations of manufacturers in despatching expert investigators to oversea markets. It was unanimously agreed that a strong protest should be made to the President of the Board of Trade and other Government officials upon the expenditure of taxpayers' money for the benefit of a privileged group of members of an association of manufacturers, such information not to be available to firms outside the association or the general public until after an interval of twelve months. Apart from the injustice of spending public money for the benefit of a privileged few, it is well-known outside of Government Departments that associations of merchants and associations of manufacturers have always been ready and willing to send out travelling representatives at the expense of their own organisations. It is difficult, therefore, to see what excuse the Commercial Intelligence Department of the Board of Trade have for laying this additional burden upon taxpayers at the present moment, which can scarcely be considered favourable for lavish and needless Government expenditure."

Messrs. Bolling & Lowe, 2, Laurence Pountney Hill, London, E.C.4, in their annual report on the iron and steel and allied trades, remark that it is required of the trading as it is of every other section of the community, that its operations shall be so shaped and dictated as to contribute a maximum to the national effort, and the rôle of the city merchant is, therefore, not what it used to be, and his usefulness to the community can no longer be judged by the same standards as in pre-war days. Government control is the order of the day in export business at the moment, and there is no early prospect of the grip of this control being relaxed, or indeed of a halt being cried to the multiplication of the directions in which it is exercised. "We regret," Messrs. Bolling & Lowe continue, "in common with many others, the apparent slight upon city merchants as a class, which gave rise to the convening of the meeting held at the Cannon Street Hotel on October 25. The hardships resulting to merchants from the lack of expert representation on Governmental trade committees are self-evident, but the fact that the meeting in question was able to command the sympathetic, active and unanimous support of the most influential representatives of the various trade interests, in itself disposed of any suggestion which might linger in the minds of some, that there is no longer room for a merchant community in the general scheme of things. Whatever be the basis of our national reconstruction after the war, we have no hesitation in saying that no scheme will succeed, or can indeed hope for the approval and co-operation necessary to success of traders at large, which does not give free scope for the exercise of their legitimate functions to the mer-

chants of the community who are as essential to trade as is trade to national prosperity."

THE NON-FERROUS METALS BILL was considered by members of the London Metal Exchange at a recent meeting, and, generally speaking, those present approved the principle of the Bill. The principal firms in the trade were represented, Mr. R. W. Rucker being voted to the chair. Mr. A. Strauss, M.P., in the course of a short speech, disapproved altogether of the measure, which he considered would tend to the repression of trade. Subsequently Mr. C. L. Budd, of Messrs. Vivian Younger & Bond, proposed the following resolution:—"That this meeting of members of the London Metal Exchange approves the principle of the Non-Ferrous Metal Industry Bill." Mr. H. Gardner opposed the resolution, as he thought the Bill was bad, although he was in agreement with the object of preventing enemies from obtaining control of the mineral resources of the Empire. The resolution was, however, adopted with few dissentients. The Committee of the Exchange were afterwards appointed a committee to consider the Bill. It was also considered at a meeting of the council of the North of England Association of Iron and Metal Merchants, and ultimately it was decided to give support to the Bill with the amendments suggested by the Committee of the London Metal Exchange, but with the following proviso:—"That the Board of Trade shall not have power to refuse a licence to any British firm or person, who has already been engaged in the metalliferous trade prior to the year 1915, unless for good cause shown." Respecting the Imports and Exports Temporary Control Bill, the following resolution was agreed to:—"That the committee having considered the Imports and Exports (Temporary Control) Bill is strongly opposed to the proposal to continue Government control of imports and exports for three years after the war, on the grounds that in the interests of the country it is necessary that the ordinary course of business should be resumed with the least possible delay."

SOME striking pronouncements on "Labour and Capital after the War" were made recently at Sheffield University by Mr. W. L. Hichens, chairman of directors of the firm of Cammell, Laird & Company, Limited. It was one of the most hopeful signs of the times, he said, that the labour problem was now being discussed and ventilated in a way that was not possible before the war. Formerly people used to shrug their shoulders when the subject was mentioned, and to say there was bound to be trouble in the long run, but it could not be helped, and we should have to fight it out when it came. Now, however, thinking people were getting to grips with the problem, and had made up their minds that in a civilised community it was ridiculous to shrug one's shoulders and say that problems had to solve themselves. Those who did think keenly about the problem before the war were often cranks, if he might use that term without offence. They were the people who had one idea, one panacea, for the solution of the problem—co-partnership, State Socialism, or some other "ism." His own conviction, however, was that there was no one cut-and-dried solution of this many-sided problem. Having remarked that there was a tendency at the present time to exaggerate the evils of the industrial situation, Mr. Hichens warned reformers against progressing "on the path of destruction," as, for instance, represented by the demand to eliminate the employer altogether, until they had something equally as efficient and concrete to put in his place, otherwise disaster would result. "But do not mistake me," he added, "for I believe a fundamental change is absolutely necessary after the war if we are to establish industry on a fair and sound basis." Labour was entitled to fair remuneration in relation to the other part of the community—whether that part be other workers or capital—and not more. It was vital that the position thus reached should be accepted as binding and obligatory on all parties, otherwise we arrived at a position little removed from anarchy. Just as it was true capital must be rewarded and must accept the conditions, so it was true labour must agree that there was a fair and reasonable reward for itself which it could not settle dictatorially. Three partners had to be considered in the solution of this problem, not two only, as was often thought to be the case by the rival combatants. These were—labour, capital, and the community.

Legal.

High-Speed Steel Patents

In the Chancery Division, Mr. Justice Younger has concluded the hearing of the petition of Arthur Balfour & Company, Limited, of Dannemora Steel Works, Sheffield, for revocation of Letters Patent, No. 27,838 of 1912, granted to Stahlwerk Becker, A.G., for an alleged invention for high-speed tool steel. The petition is resisted by the patentees and by Darwin & Milner, Limited, of Commercial Street, Sheffield, who claim to be licensees of the patent. The grounds for the petition are prior user and lack of novelty.

Mr. Balfour, in cross-examination, said his firm were large manufacturers of high-speed steel. They did not notify their customers or the public by advertisement or other documents that they were using cobalt, but in December, 1912, after the date of the patent, in reply to a letter from Messrs. E. G. Ward & Son, calling attention to the use being made of cobalt in high-peed steel, he wrote that they had been using cobalt for over a year in high-speed steel.

Counsel for Messrs. Darwin & Milner said this attack on the patent was made because the licensees had been making and selling all they could get of this special kind of high-speed steel, and advertising it largely. It was found to be so valuable as to cause people to pay the higher price charged for it. This was an invention which might be of enormous importance, and the petitioner's attempt to close the mouths of Messrs. Darwin & Milner by objecting that they could not be heard could not be justified. The respondents were now met by an alleged prior user, which they had had no opportunity of inquiring into. The fact that there was a prior user of cobalt in high-speed steel came as a total surprise to the trade. He submitted that the petitioner had proved nothing here more than an abandoned experiment.

His Lordship said it was clear that on February 22, 1911, high-speed tool steel under the letters and numbers S.A. 147 was manufactured by the petitioners, and that this contained cobalt. It was true that in 1911 it was not, in fact, extensively sold or put upon the market, but the petitioners had manufactured this steel in increasing quantities since 1912, and it had been put in the hands of purchasers in Canada and the United States before the date of the patent. It was important to note that the invention claimed was for a mere prescription, and that it was in no sense for a process of manufacture. It was admitted that the ingredients and percentage could be easily ascertained by analysis by any competent chemist. He was satisfied that before the date of the patent the petitioners' "S.A. 147" steel had ceased to be in its experimental stage, and that there was sufficient publication to make the patent invalid. He therefore made an order revoking the patent.

On the application of Mr. Kerly, K.C., his Lordship granted a stay for six weeks in order that the patentee in Germany may be communicated with.

Mr. Moritz, for the patentee, intimated that he intended to apply for leave drastically to amend the patent, a course frequently adopted in the case of the revocation of a patent.

Deaths.

THE death is announced of Mr. J. C. Merryweather, of Messrs. Merryweather & Sons, of Long Acre and Greenwich, in his 78th year.

CAPT. WM. NEILSON, who has been killed in action, was the eldest son of the late Mr. Hugh Neilson, of the Clydebridge Steel Works.

THE death occurred recently, at his residence, The Sycamores, Pelsall, at the age of 68, of Mr. Ernest Wilkes, engineer and ironfounder.

CAPT. C. G. VICKERS, who was killed in action on November 22, was the youngest son of Mr. C. E. Vickers, of the Manor House, Ecclesall, Sheffield.

MR. T. DIXON, of Longlands West, Grove Hill, Middlesbrough, who for many years was director and secretary of Sir Raylton Dixon & Company, Limited, shipbuilders, died last month.

MR. D WAINE, head of Messrs. J. Waine & Sons, Britannia Lock Works, Willenhall, and Messrs. G. Grimley & Company, Hall Stamping Works, Willenhall, died recently at the age of 66 years.

THE death occurred on December 14, at Prince's Park Mansions, Liverpool, of Mr. E. Walmsley, of the firm of Thomas Walmsley & Sons, Bolton. The deceased gentleman was 44 years of age.

THE death took place last month of Mr. J. B. Fullarton, assistant manager in the Clydeholm Shipyard of Messrs. Barclay, Curle & Company, of Whiteinch and Scotstoun West.

SEC.-LIEUT. P. NISBET-CUNNINGHAM, killed in action, was the younger son of Mr. W. Cunningham, Rockland, Wishaw, a director of the Etna Iron and Steel Company, Limited, Motherwell. He was 25 years of age.

SEC.-LIEUT. W. R. BENNIE, killed in action, was in his 23rd year, and was the younger son of Mr. A. Bennie, one of the directors and secretary of John Wallace & Sons, Limited, agricultural engineers, Glasgow.

SEC. LIEUT. S. HETLEY PEARSON, Grenadier Guards, killed in action, was a son of the late Mr. H. J. Pearson, of Bramcote, Notts. He was educated at Charterhouse, and became a director of the Beeston Foundry Company, Limited.

LIEUT. G. HAMMOND LORD, R.F.A., whose death at the front from accidental injuries is reported, was a son of the late Mr. G. H. Lord, and a partner of the firm of G. H. Lord & Son, engineers and mill furnishers, Ward Road, Dundee.

MR. H. F. MADDISON, eldest surviving son of the late Mr. Henry Maddison, and joint managing director of the firm of Messrs. Ord & Maddison, agricultural implement engineers and limestone quarry owners, of Darlington and Weardale, died on Tuesday, aged 53.

CAPT. MALCOLM MCNICOLL, K.O.Y.L.I., is reported killed. He was the second son of the late Mr. D. McNicoll, and had been with the Hardy Patent Pick Company, Limited, for over twenty years. During the last four years he was the firm's technical representative in Austria, Hungary and Russia.

LIEUT. DAVID R. FERGUSON, R.E. (killed), was a son of Mr. D. Ferguson, Kirkfield, Johnstone. A partner in the engineering firm of Messrs. Ferguson Bros., Johnstone, he was also assistant lecturer on mechanical engineering in Glasgow University, where he graduated B.Sc. He had been mentioned in despatches.

MAJOR W. R. WHITSON, killed in action, was the son of Mr. A. Whitson, Glasgow. He was educated at Glasgow Academy and Glasgow University, where he graduated B.Sc. in Engineering. He served his apprenticeship as an engineer with Messrs. Duncan Stewart & Company, Messrs. D. Rowan & Company, and Messrs. Denny, Dumbarton.

MR. J. BUCHANAN, managing director of the Liverpool engineering firm of James Buchanan & Son (Liverpool), Limited, Caledonia Foundry and Engine Works, died recently. Mr. Buchanan was admitted a partner in the firm in 1877, and under his direction the business made steady and considerable progress, the works being now one of the most important industrial concerns in the district.

THE death is reported of Mr. A. Adair, metallurgist and chemist, at the age of 63 years. The deceased received his education at Owens College, Manchester, and the Royal School of Mines, London, and during his career had been chemist at the Seaton-Carew Ironworks, and Messrs. Nobel's Works in Scotland. Among his many patents were the Adair-Cruikshanks process of fine grinding and the Adair-Usher process for drilling with slimes.

MR. J. H. MACKINLAY, son of the late Dr. J. E. Mackinlay, J.P., of the Green House, Coatham, died recently. The deceased gentleman was well known in Redcar, and was held in the highest esteem by all who knew him, and not least by those who served under him at the Lackenby and Cargo Fleet Ironworks, where he occupied responsible positions before his appointment as general manager of the Lilleshall Company, Limited, Prior's Lee Hall, Salop, Shropshire, less than six years ago.

CAPT. A. N. COUSIN, York and Lancaster Regt., has been killed in action. He was educated at University College, London, where he gained his engineering diploma, and first-class honours Bachelor of Science Degree. Amongst other honours, he won first prizes there for thermo dynamics, graphics, machine design, "The Ellen Watson Memorial" Scholarship, 1912, and in 1913 the Industrial Bursary, awarded by the 1851 Exhibition Commissioners. He afterwards entered the works of Vickers, Limited, Sheffield.

THE death took place recently, after a short illness, of Mr. L. Rusden, at his residence at Newcastle. The deceased gentleman commenced work with Messrs. Thompson & Boyd, engineers, Gallowgate. He became chief draughtsman of the Wallsend Slipway and Engineering Company, and was subsequently manager for nine years. He was one of the pioneers of the introduction of oil fuel for marine boilers. Mr. Rusden was a member of the Institution of Naval Architecture, the North-East Coast Institution of Engineers and Shipbuilders, and the Newcastle and District Association of Foremen Engineers and Mechanical Draughtsmen, of which association he was president in 1888.

THE death is reported from Dartmouth, in his 78th year, of Mr. E. Matheson, who for many years was one of the foremost civil engineers in the country. Mr. Matheson was born in 1839, in London, and at an early age was apprenticed with the engineering firm of Handyside & Company, of Derby. Soon after he was out of his time, he was appointed to be the firm's agent in London, and later he became a director. It was through Mr. Matheson's knowledge and under his direction that so many large buildings and bridges were built by Messrs. Handyside. The best-known examples of the work done by the firm under Mr. Matheson's direction are the railway stations at St. Pancras, London, St. Enoch's, Glasgow, and the Central Station, Manchester; the roofs of the Agricultural Hall and Olympia in London, as well as a large number of road and railway bridges in England, Europe, and the Colonies. These works led to the formation of the firm of Messrs. Matheson & Grant, London, consulting engineers, in which he was the principal partner. In 1887 Mr. Matheson accepted the post of managing director of the Farnley Iron Company, bringing to the service of the company the great knowledge which was so thoroughly recognised by his own profession. Elected a member of the Institution of Civil Engineers in 1876, he was always an active member of that body, and he won the Telford Premium. He retired from business at the end of 1910.

New Companies.

Monazite Products, Limited.—Capital £30,000 in £1 shares.

Claylane Engineering Company, Limited.—Capital £2,000 in £1 shares.

Auxiliary Engineering Company, Limited.—Capital £5,000 in £1 shares.

Aero-Motor Engineering Company, Limited.—Capital £10,000 in £1 shares.

Edgware Engineering & Aircraft Company, Limited.—Capital £100 in £1 shares.

T. Shipside, Limited.—Capital £10,000 in £1 shares, to carry on the business of engineers.

Beta Engineering Company, Limited.—Capital £1,500 in £1 shares, to acquire the existing business.

Higgin Brothers & Jones, Limited.—Capital £5,000 in £1 shares, to carry on the business of ironfounders.

Alphæro Engines, Limited.—Capital £21,500 in £1 shares. Registered office:—57, Gracechurch Street, E.C.

Structural Engineering, Limited.—Capital £1,000 in £1 shares. Registered offices:—34, Victoria Street, S.W.

Thomas Welsh & Company, Limited.—Capital £50,000 in £10 shares, to carry on the business of shipbuilders.

Scriven & Company, Limited.—Capital £20,000 in £1 shares (10,000 preference), to carry on the business of engineers.

Birmingham Aircraft Company, Limited.—Capital £100 in £1 shares. Registered office: 7, Waterloo Street, Birmingham.

Elms Aircraft & Motor Works, Limited.—Capital £10,000 in 9,750 preference shares of £1 each, and 5,000 ordinary shares of 1s. each.

Engineering & Aircraft Construction Company, Limited.—Capital £5,000 in £1 shares. Registered office: 329, High Holborn, W.C.

General Foundry Supplies Company (London), Limited.—Capital £6,000 in £10 shares. Registered offices:—119, High Holborn, W.C.

H. Fuller & Company, Limited.—Capital £500 in £1 shares, to carry on the business of ironmasters. Registered office:—87, Fargate, Sheffield.

E. Hunt & Company, Limited.—Capital £5,000 in £1 shares, to carry on business as engineers. Registered office: 2, Mellish Street, Millwall, E.

Amorduct British Company, Limited.—Capital £50,000 in £1 shares, to acquire the undertaking of the Armorduct Manufacturing Company, Limited.

E. B. T. Syndicate, Limited.—Capital £20,000 in £1 shares, to carry on the business of engineers. Registered office:—5, Thavies Inn, Holborn Circus, London.

J. Jackson, Limited.—Capital £10,000 in £1 shares (5,000 preferred), to carry on the business of engineers. Registered offices:—Bramley, near Guildford, Surrey.

Henry Ponder & Company, Limited.—Capital £10,000 in £10 shares, to carry on the business of metal merchants. Registered office:—45, Bethnal Green Road, E.

Hollow Structure & Aircraft Company, Limited.—Capital £55,000 in 25,000 £1 shares and 60,000 10s. shares. Registered offices: 4, Old Burlington Street, W.1.

United Production Company, Limited.—Capital £500 in £1 shares to carry on the business of engineers, etc. Registered office: Stanton Works, Stanton Road, Barnes, S.W.

Ashford Aircraft Works, Limited.—Capital £10,000. in 9,750 preference shares of £1 each, and 5,000 ordinary shares of 1s. each. Registered office: Cree House, Creechurch Lane, E.C.

Rare Metals, Limited. — Capital £50,000 in 25,000 pref. ord. shares of £1 each, and 50,000 ord. shares of 10s. each. Registered office: 3, St. Bride's House, Salisbury Square, E.C.4.

Shareholders' Aircraft Syndicate, Limited. — Capital £1,000 in 3,600 "A" shares of 5s. each, and 24,000 "B" shares of 1d. each. Registered office: 20, Northampton Park, Canonbury, N.

Adam Knox & Sons, Limited.—Capital £5,000 in £1 shares, to acquire the existing business of engineers and machine makers, etc. Registered office:—47, Crownpoint Road, Glasgow.

H. C. Siddens & Company, Limited.—Capital £25,000 in £1 shares (24,700 pref.), to carry on the business of iron and steel merchants, etc. Registered office:—Exchange Buildings, Birmingham.

W. and D. Conveyor Engineering Company, Limited.—Capital £10,000 in £1 shares. The first directors are H. O. King, T. Fletcher, W. H. Weguelin, W. E. P. Doudney, and C. H. Bennett.

Baker Cramer Engineering Company, Limited.—Capital £5,000 in £1 shares. The first directors are F. W. R. Cramer and W. T. Baker. Registered office: Old Mills, Camp Road, Leeds.

Ryle Samuel & Company, Limited.—Capital £1,000 in £1 shares, to take over the existing business of metal ware manufacturers and engineers. Registered office:—66, Pershore Street, Birmingham.

Az-Nu Engineering Company, Limited.—Capital £12,000 in 10,000 pref. and 2,000 ord. shares of £1 each, to carry on the business of engineers. Registered office:—261, Church Road, Mitcham.

H. O. Thompson, Limited.—Capital £1,000 in 750 preference shares of £1 each and 5,000 founders' of 1s. each, to carry on the business of general engineers, etc. Registered Office:—20, Budge Row, E.C.4.

Trusty Manufacturing Company, Limited.—Capital £1,000 in £1 shares, to take over the engineering business carried on by H. Cooke and A. G. Haworth at Park Place, Higher Ardwick, Manchester.

David Carlaw & Sons, Limited.—Capital £40,000 in £1 shares, to acquire the business of David Carlaw & Sons, engineers and machine makers, Glasgow. Registered office:—11, Finnieston Street, Glasgow.

B. M. Renton & Company, Limited.—Capital £10,000 in £1 shares, to take over the business carried on as B. M. Renton & Company, iron and steel merchants, at Sheffield. The first director is F. B. Bottomley.

Hamilton, MacLellan Syndicate, Limited.—Capital £27,500—50,000 A shares of 1s. each, and 25,000 B shares of £1 each, to carry on the business of shipbuilders, etc. The first directors are J. Hamilton and W. T. MacLellan.

McBain Bros., Limited.—Capital £5,000 in £1 shares, to carry on the business of mechanics, electric, marine, constructional, internal combustion, and general engineers, etc. The first directors are W. J. McBain and A. McBain. Secretary, A. G. Greaves.

Heathcotes (Cleator Moor), Limited.—Capital £5,000 in £1 shares, to carry on the business of ironfounders, engineers, etc. The first directors are W. Johnson, C. R. Mossop, W. Reid, F. Watson, and T. T. Watson. Registered office:—Birks Road, Cleator Moor, Cumberland.

Gillies Engineering Company, Limited.—Capital £2,000 in 1,500 pref. and 500 ord. shares of £1 each, to acquire the business of engineer and blacksmith at present carried on by J. Anderson and D. Stewart, Bonnybridge. Registered office:—Bonnybridge Forge, Bonnybridge.

Robert Jenkins & Company, Limited. — Capital £15,000 in £1 shares (2,000 preference), to take over the engineering business of A. T. Jenkins. The first directors are: A. T. Jenkins, R. W. Jenkins, E. J. Jenkins, and H. C. Jenkins. Registered office: Ivanhoe Works, Wortley Road, Rotherham.

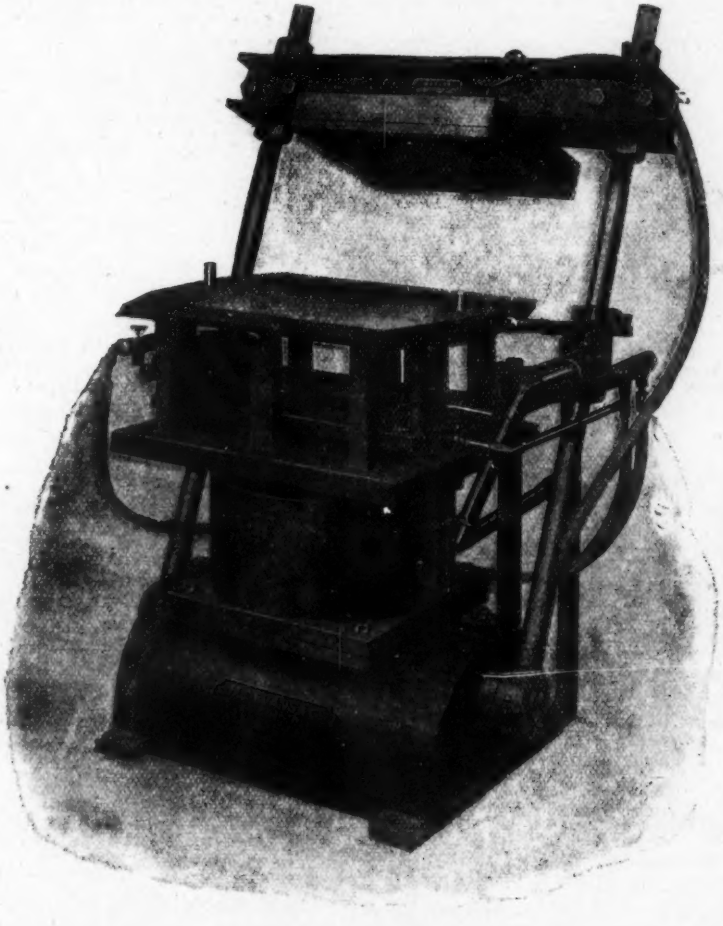
Thames Side Engineering Company, Limited.—Capital £2,000 in £1 shares, to take over the engineering business of W. Miller, carried on at the Erith Motor Works, Pembroke Road, Erith. The first directors are C. Whinnerah, W. Riley, G. Pickard, W. Miller, F. Butterfield, P. V. Lord, W. Fraser, and T. Murdoch.

Scriven & Company.—Capital £20,000 in £1 shares, to take over the business carried on by Scriven & Company at the Leeds Old Foundry, Leeds, engineers, machine-tool makers, iron, steel and brass founders, metal workers, boiler makers, electrical engineers, manufacturers of coal tar derivatives, etc.

MOULDING MACHINES

OF EVERY DESCRIPTION.

Pneumatic, Hydraulic, Jar Ramming, & Hand Power.



JAMES EVANS & CO., BRITANNIA WORKS,

BLACKFRIARS, **MANCHESTER.**

Personal.

ESTATE of the value of £14,079 gross has been left by the late Mr. T. Jenkins, engineer, of Clifton.

MR. P. C. QUILTER has been elected to the Board of the Blaenavon Company, Limited.

ESTATE of the gross value of £9,663 has been left by the late Mr. J. B. Bradford, steelworks manager, of Darlington.

THE value of the personal estate left by the late Mr. J. Gibson, of the Scottish Iron and Steel Company, Limited, is £21,211.

MR. F. DUDLEY DOCKER, M.P., has joined the board of the British Westinghouse Electric and Manufacturing Company, Limited.

THE late Mr. J. Gibson, iron manufacturer, late of Iddesleigh, Coatbridge, left personal estate in the United Kingdom and abroad valued at £21,818.

MR. A. W. C. SHELF has been awarded by the council of the Society of Engineers the Bessemer Premium for his paper, "High Tensile Steel versus Mild Steel."

THE late Mr. A. E. Lamb, ironworks manager, of Whinney Hill, Cleator Moor, Cumberland, left estate valued at £4,919 7s. gross, with net personalty £4,182 9s.

ESTATE of the gross value of £174,647 has been left by the late Mr. George Salter, J.P., of George Salter & Company, Limited, spring and gauge manufacturers, West Bromwich.

LIEUTENANT F. A. SHEEN, R.E., who has been awarded the Military Cross, was a member of the firm of Pollard & Company, Limited, engineers, before the outbreak of war.

MR. C. J. HUNT, chief engineer to Bruce Peebles & Company, Limited, was married on December 22. He has been the recipient of a presentation from the officials and staff.

MR. J. FULLERTON, whose appointment as a member of the Committee on Production has been notified, is the senior partner of Messrs. John Fullerton & Company, shipbuilders, Merksworth, Paisley.

THE late Mr. P. G. B. Westamott, formerly managing director of Sir W. G. Armstrong, Whitworth & Company, Limited, left a fortune of the value of £144,192, the net personalty being £120,675.

SEC. LIEUT. R. A. CARTLEDGE, R.F.C., son of Mr. A. Cartledge, steel, tinplate, and metal agent, Suffolk House, Laurence Pountney Hill, London, E.C.4, has been wounded and is a prisoner in Germany.

MR. H. FOULDS has been appointed secretary of Callender's Cable and Construction Company, Limited, and the Anchor Cable Company, Limited, in succession to Mr. W. Allnutt, who has resigned, in consequence of advanced age.

LIEUT. NORMAN DUGDALE, R.G.A., who has been mentioned as having been awarded the Military Cross for conspicuous gallantry, is the second son of Mr. W. H. Dugdale, managing director of S. P. Austin & Son, Limited, shipbuilders and repairers, Sunderland.

LIEUT.-COL. W. S. RICHMOND, Assistant Director of Roads in France, and son of Mr. J. Richmond, of Messrs. S. Pontifex & Company, engineers and ironfounders, Euston Street, London, N.W., has been gazetted Deputy Director of Roads, with the rank of Colonel.

MR. T. A. WALKER, of Messrs. Walker Bros., Pagefield Ironworks, Wigan, has offered to erect the Narthex at the Holy Trinity Church, Southport, as a memorial to his two sons, Lieutenant Basil Walker and Lieutenant Courtmel Walker, who have been killed in the war, and the gift has been accepted.

IN recognition of invaluable services to the Ministry of Munitions, the President of the French Republic has presented the Hon. Col. William Charles Wright, Reserve of Officers, with the decoration of the Croix de Chevalier of the Legion d'Honneur. Col. Wright is the only son of Col. J. Ropar Wright, J.P., D.L., He is a director of Baldwins, Limited.

T. & I. BRADLEY & SONS, LTD.,

DARLASTON, South Staffs.

SPECIAL COLD BLAST PIG IRONS.

Brands:

R.A.M. FOR CYLINDERS.

IXL. C.B.R. FOR CHILLED CASTINGS, &c.

D.M.R. CHARCOAL FOR MALLEABLE CASTINGS, &c.

* SELECTION * ANALYSIS * FRACTURE AND CHILL * GUARANTEED *

ALL MINE.	WARM BLAST.	COLD BLAST.
◆ A M ◆	I X L.	I X L.-CB.

☛ IF YOU HAVE DIFFICULTIES WITH YOUR SPECIAL CASTINGS CONSULT US.

We can put you right.

A NEW STEEL BARROW

(PATENTED).

"BRABY'S BALANCED BARROW."

The Handiest and Cheapest Barrow in the market. Specially designed for coal, dross, ashes, etc. Its capacity is 25 per cent. greater than the ordinary style, yet it can be wheeled with half the labour, and can be emptied much more quickly. It is a perfectly balanced barrow, and a full load can be easily wheeled by a boy.

NOTE.—This Barrow can be taken right up to mouth of furnace and the ashes drawn into the barrow direct from the furnace.

The "B.B.B."

BRABY for high grade **STEEL**
SHEETS and PLATES up to 15 FEET LONG.
RANGE OF GAUGES 8 to 30 W.G.
RANGE OF WIDTHS 12 to 60 in.

BRABY for improved wrought **STEEL**
BARROWS, BOGIES, TRUCKS,
GUTTERS, PIPES, &c.

BRABY for Iron and **STEEL**
ROOFS and BUILDINGS.

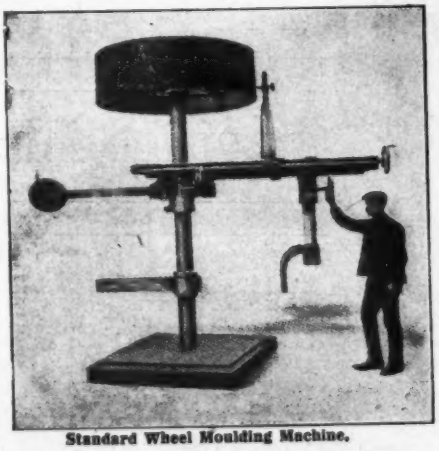
BRABY for unbreakable **STEEL**
SASHES, CASEMENTS, and
PUTTYLESS ROOFLIGHTS.

BRABY for galvanised corrugated **STEEL**
SHEETS: "EMPRESS" and "SUN" BRANDS.

FREDERICK BRABY & Co., Ltd., Eclipse Iron and Galvanising Works and Steel Sheet Rolling Mills, Petershill Road, GLASGOW.

Show Rooms and Aluminium Warehouse, 124, St. Vincent Street, Glasgow.
Rustless Iron, Galvanising and Copper Works, FALKIRK.

Also at London, Deptford, Liverpool, Bristol, Belfast, and Dublin. CONTRACTORS to BRITISH and FOREIGN GOVERNMENTS. Telegrams—"Braby, Glasgow."



Standard Wheel Moulding Machine.

ALL IRON AND STEEL FOUNDRIES

SHOULD BE EQUIPPED WITH

STEWART WHEEL MOULDING MACHINES.

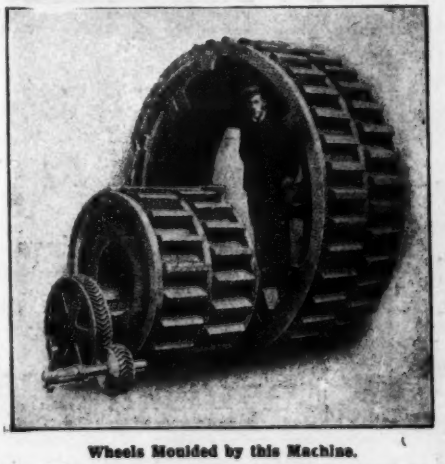
Complete Satisfaction Guaranteed

No Loose Parts Liable to be Lost.

ACCURATE. PORTABLE. CHEAP.

WRITE FOR PRICE AND PARTICULARS TO

DUNCAN STEWART & CO., LTD.,
LONDON ROAD IRONWORKS, GLASGOW.



Wheels Moulded by this Machine.

Modification of General Permit as Regards Dealings in Pig-Iron.

With reference to the Order made by the Minister of Munitions on July 7, 1916, applying Regulation 30A of the Defence of the Realm Regulations to war material consisting of certain classes and descriptions of metallurgical coke, pig-iron and steel, and to the General Permit for dealing in such war material issued by the Minister of Munitions on November 1, 1916, the Minister of Munitions now gives notice:—(1) That the said General Permit is modified by the insertion in the Schedule thereto of the following, the prices for the articles hereunder specified being in addition to or, where such articles are already specified in such Schedule, in substitution for the prices contained in the schedule.

Maximum Prices for Pig-iron above referred to; Hematite Pig-iron—East Coast and West Coast.—The expression "Mixed Numbers," where used in relation to East Coast and West Coast pig-iron in the Schedule to the said General Permit shall mean equal quantities of Nos. 1, 2 and 3 having an average analysis within the following limits:—

	East Coast. Per cent.	West Coast. Per cent.
Silicon	1¾ to 3¼ ...	1¾ to 3¼
Manganese, not exceeding	1¾ ...	1¼
Sulphur ,,	0.06 ...	0.05
Phosphorus ,,	0.06 ...	0.05

The following extras may be charged on sales of East Coast and West Coast hematite pig-iron:—

All hematite pig-iron selected to any particular number, grade or analysis or manufactured to a specified analysis within the limits covered by Mixed Numbers ...	2s. 6d. per ton.
All hematite pig-iron selected or manufactured to a specified analysis outside the limits covered by Mixed Numbers with a silicon content below 5 per cent.	5s. per ton.
Silicon 5 per cent. and less than 6 per cent.	10s. per ton.
Silicon 6 per cent. and less than 7 per cent.	15s. per ton.

All the above additions to the Schedule of the General Permit shall take effect from the date of this notice, and none of such additions shall be deemed to prejudice or interfere with the carrying out of any contract in writing for sale or purchase of the above-mentioned war material entered into prior to such date at prices lawful at the date of such contract.

Substituted prices per ton, net, f.o.t. makers' works.

Cleveland pig-iron—foundry and forge:—	
No. 1	£4 19s. 0d. per ton.
Other grades	£4 15s. 0d. per ton.
Cleveland pig-iron—basic ...	£5 0s. 0d. per ton.

The above substituted prices shall take effect from September 17, 1917.

Lincolnshire pig-iron, basic or foundry	£4 17s. 6d. per ton.

The above substituted price shall take effect from November 1, 1917.

The Mastery of the Air.

SIROCCO

TRADE ... SIROCCO ... MARK

FANS

SEND US YOUR ENQUIRIES FOR

are always successful in the struggle for the Mastery of the Air

Ventilation of Ships, Buildings and Mines, Induced Draught on Boilers, Dust Removal, High Pressure Fans for Forge Fires and Cupolas, Air Washers for Cooling and Purifying the Air, Fans for Removing Fumes or Steam, Steam Heater Units for Heating Factories and Workshops.

Davidson & Co., Limited, *Sirocco Works,* BELFAST.

Telegrams: "Durrans, Penistone." Telephone: 21, Penistone

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.

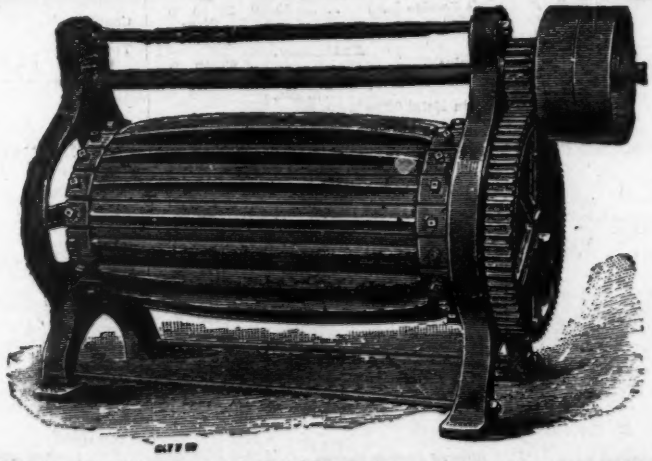
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself:—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

MONTHLY PRICE LIST.

The undermentioned prices, unless otherwise specified, are those obtaining at the commencement of the current month.

CONTROL PRICES.

Pig-Iron.

	£	s.	d.
West Coast hematite, mixed Nos. 1, 2 and 3	6	7	6
Special under 0.03 P. & S... ..	6	15	6
„ „ 0.02 „	7	0	0
East Coast hematite, mixed Nos. 1, 2 and 3	6	2	6
Special under 0.04 P. & S. ..	6	7	6
Special under 0.03 P & S. ..	6	15	6
„ „ 0.02 „	7	0	0
Scotch hematite, mixed Nos. 1, 2 and 3..	6	2	6
Special under 0.03 P. & S. ..	6	15	6
„ „ 0.02 „	7	0	0
HEMATITE—MALLEABLE— Refined—			
Refined Cupola Cast	8	0	0
Refined Cupola Cast to guaranteed analysis..	8	5	0
Cast direct from Blast Furnaces—			
Small Pig-Iron, all grades ..	7	10	0
Medium Pig-Iron White to Grey mottled	7	5	0
Medium Pig-Iron, all other qualities	6	17	6
Large Pig-Iron, all grades ..	6	17	6
Lincolnshire, basic or foundry ..	4	17	6
Cleveland, No. 1	4	19	0
„ other grades	4	15	0
„ basic	5	0	0
Northamptonshire, forge	4	7	6
„ fdy numbers 89/0		94/0	
„ basic	4	17	6
Derbyshire, forge	4	10	0
„ foundry numbers 92/6		96/6	
Derby & Notts. basic.	4	17	6
Leicestershire & Notts., forge ..	4	10	0
„ „ foundry nos. 92/6		96/6	
North Staffs, forge	4	15	0
„ „ foundry	4	17	6
„ „ basic	4	17	6
South Staffordshire— Part mine forge	5	0	0
„ foundry	5	2	6
Common Staffordshire ..	4	15	0
All mine forge	5	15	0
„ foundry	6	0	0
Warm air forge	7	5	0
„ foundry	7	15	0
Lord Dudley's silicon	8	7	6
Cold blast	9	2	6
Basic	4	17	6
Scotch foundry and forge— Nos. 2, 4, and lower grades of Monkland, Dalmellington, Eglinton, and Govan.. ..	5	14	0
Nos. 3, 4, and lower grades of all other brands	5	15	6

No. 1 quality in all cases to be 5s. per ton above these prices.

All per ton net, f.o.t. makers' works. Mers. Com. 1½%

In all districts 1s. extra may be charged for Basic cast in chills.

High-Speed Tool Steel.

The maximum prices for high-speed tool steel have been fixed as follows:—

Finished bars, 14% Tung. 2s. 10d.

Finished bars, 18% Tung. 3s. 10d.

Per lb. basis. Extras as per authorised list. These prices are net delivered buyers' works.

The fixed prices for scrap which must be returned to steel makers' works are as follows:—

Millings and Turnings .. .. 5d.

Bar Ends .. .. 6d.

Both per lb. net delivered steel makers' works.

Ferro-Alloys

Net, Delivered Sheffield steel works.

	£	s.	d.
Ferro chrome: 4/6% carbon. Basis 60%, scale 10s. per unit Per ton	—		
Ferro-chrome: 6/8% carbon. Basis 60%, scale 10s. per unit. Per ton	—		
Ferro-chrome: 8/10% carbon. Basis 60% scale, 10s. per unit Per ton	—		
Ferro-chrome: Specially refined, guaranteed maximum 2% carbon broken to small pieces for use in best quality crucible steels. Basis 60%, scale 32s. per unit. Per ton	—		
Ferro-vanadium: 33/40% Va., per lb. of Va. contained in the alloy	—		
Ferro-silicon: 45/50%. Basis 50%, 5s. scale per unit .. Per ton	—		
Ferro-titanium: 23/25%, per lb. carbonless	—		
Ferro-molybdenum: 70/80% Mo. per pound of Mo. contained ..	—		
Ferro-phosphorus: 20/25%. Per ton	—		
Ferro-tungsten: 75% to 80% per lb. of metallic tungsten contained	—		
*Ferro-manganese 80%	25	0	0
„ export £36 0 0—39	0	0	

* F.o.b. Liverpool.

Non-Ferrous Metals.

Copper.

	£	s	d.	£	s.	d.
Standard, Cash	..110	0	0	110	10	0
Three months	..110	0	0	110	10	0
Electrolytic ..	..125	0	0	121	0	0
Tough ..	..123	0	0	119	0	0
Best selected ..	..123	0	0	119	0	0

Tin.

Standard, Cash	..279	10	0	280	0	0
„ Three months	273	0	0	274	0	0
English Ingots ..				281	0	0
Bars		—		282	0	0
Refined		—			—	

Spelter.

American ..	.. 54	0	0	50	0	0
Specials..		—			—	
Hard		—		45	0	0
British ..	.. 56	10	0	57	0	0

Lead.

Soft Foreign (net)	.. 29	10	0	28	10	0
English		—			Nom.	

Antimony.

Regulus		—		85	0	0

Aluminium.

Virgin Metal 98/99% per ton	—		—

Phosphor Bronze.

INGOTS.	Per ton.
Alloy No. I. or II	—
III., IV. or V.	—
VI. or VII.	—
VIII.	—
XI.	—
Cast Strips and Ingots.. ..	—
CASTINGS.	Per lb.
I. or II.	—
III. IV. o V.	—
VI. or VII	—
VIII.	—
XI.	—
No. VII., Chill, Cast, Solid ..	—
„ Cored Bars	—

Delivery 2 Cwt. free to any town.

10 per cent. Phosphor Copper .. price of best selected copper.	£50 above
15 per cent. Phosphor Copper .. price B.S.	£70 above
Phosphor Tin (5 per cent.) .. price of English Ingots.	£30 above

(Phosphor-bronze prices supplied by CHARLES CLIFFORD AND SON, LIMITED, FAZELEY STREET MILLS, BIRMINGHAM)

***Chromium (Metallic).**

98/99% purity, per lb. — —

***Nickel.**

In cubes, 98/99% purity Per ton —

Nickel Silver.

	per lb.
Ingots for raising	—
Ingots for Spoons and Forks ..	—
„ rolled to spoon size ..	—

***Tungsten Metal Powder.**

96/98% purity.. per lb. .. —

***Molybdenum Metal.**

96/98% purity.. per lb. .. —

***Cobalt Metal.**

97% purity .. per lb. .. —

Quicksilver.

75 lb. bottle .. .. .. —

* Net, Delivered Sheffield Works.

Scrap Iron and Steel.

Cleveland.

	s.	d.	s.	d.
Steel scrap, heavy melting..	105	0	—	
Iron scrap cast (cupola metal)	90	0	95	0

London (f.o.b.).

Heavy steel			105	0
Light „			55	0
Heavy cast			95	0

Control Prices.

Heavy Steel Melting Scrap	105	0	125	0
Steel Planings, Turnings and Borings			65	0
Steel Planings, Turnings and Borings mixed with Wrought Iron, &c.			50	0
Steel Scrap, all other Classes ..			95	0
Wrought Iron Scrap			125	0
Ditto, mixed with Steel			95	0
W.I. Planings, Turnings and Borings mixed with Steel, &c. ..			50	0

Per ton delivered Buyers' Works.

Non-Ferrous Scrap.

London merchants quote the following prices for scrap metal, delivered London, and subject to market fluctuations:—

	A. Joseph. £	s.	d.
Hy. Electrolytic Copper Scrap ..	—		
Hy. Selected Scrap Brass ..	—		
Hy. Tinned Copper Wire	—		
Best Selected Gunmetal Scrap ..	—		
Re-melted Ingot Lead	—		

Stocks.

Metals.

	Tons.
Copper, Europe and afloat	—
Tin, London, Holland, U.S.A. and afloat	—

Coke.

Middlesbrough.

	s.	d.	s.	d.
Gas Coke	37	6	—	
Foundry	45	0	—	

Glasgow.

Foundry Coke	—		45	0
Furnace Coke	35	0	—	
Gas Coke	—			

London.

Welsh or Durham Foundry, d/d London Stations in truck	45	0	53	0
Ditto, d/d Birmingham Stations	44	0	48	0
Yorkshire, d/d London Stations, in truck	42	6	—	
Ditto, d/d Birmingham Stations	39	6		

CONTROL PRICES OF COKE.

	s	d.
Durham and Northumberland blast furnace	33	0
„ foundry	38	0
Yorkshire, Lancashire, Staffordshire, Notts., Derbyshire, Lincs., & Midland Counties blast furnace	32	0
South Wales blast furnace ..	37	6
„ foundry	50	6

All per ton net. f.o.t. evens.

Cumberland blast furnace	37	9
d/d West Coast furnaces	s	

SITUATIONS VACANT AND WANTED.

MOULDERS (6) and CORE MAKERS (2) wanted in Brass Foundry, London.—Apply to Box 918, Offices of the FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.2.

MOULDER.—Smart and intelligent, required to fill position as Under Foreman or Charge hand in Government Controlled factory, principally occupied on engine castings. Position would be a permanent one and provides good opening for energetic man. No person already on Government work will be engaged.—Apply stating age, experience and wages required to your nearest Employment Exchange, quoting No. A4335.

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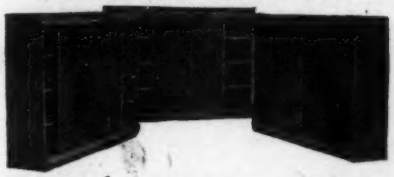

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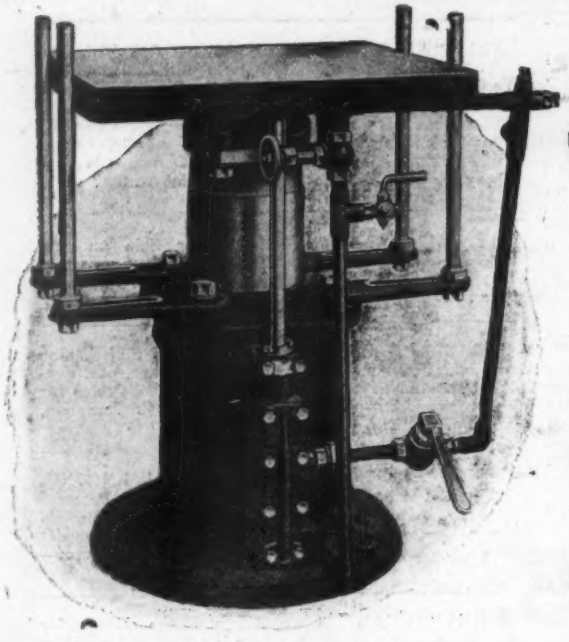

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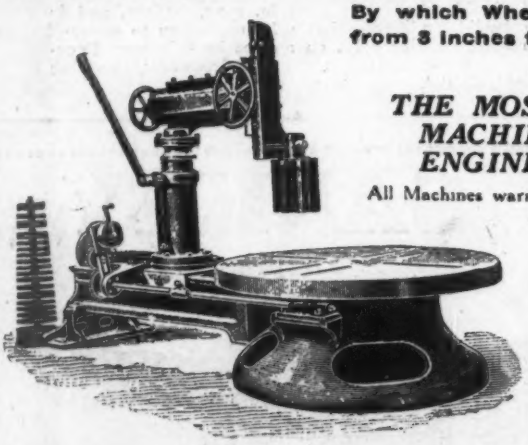

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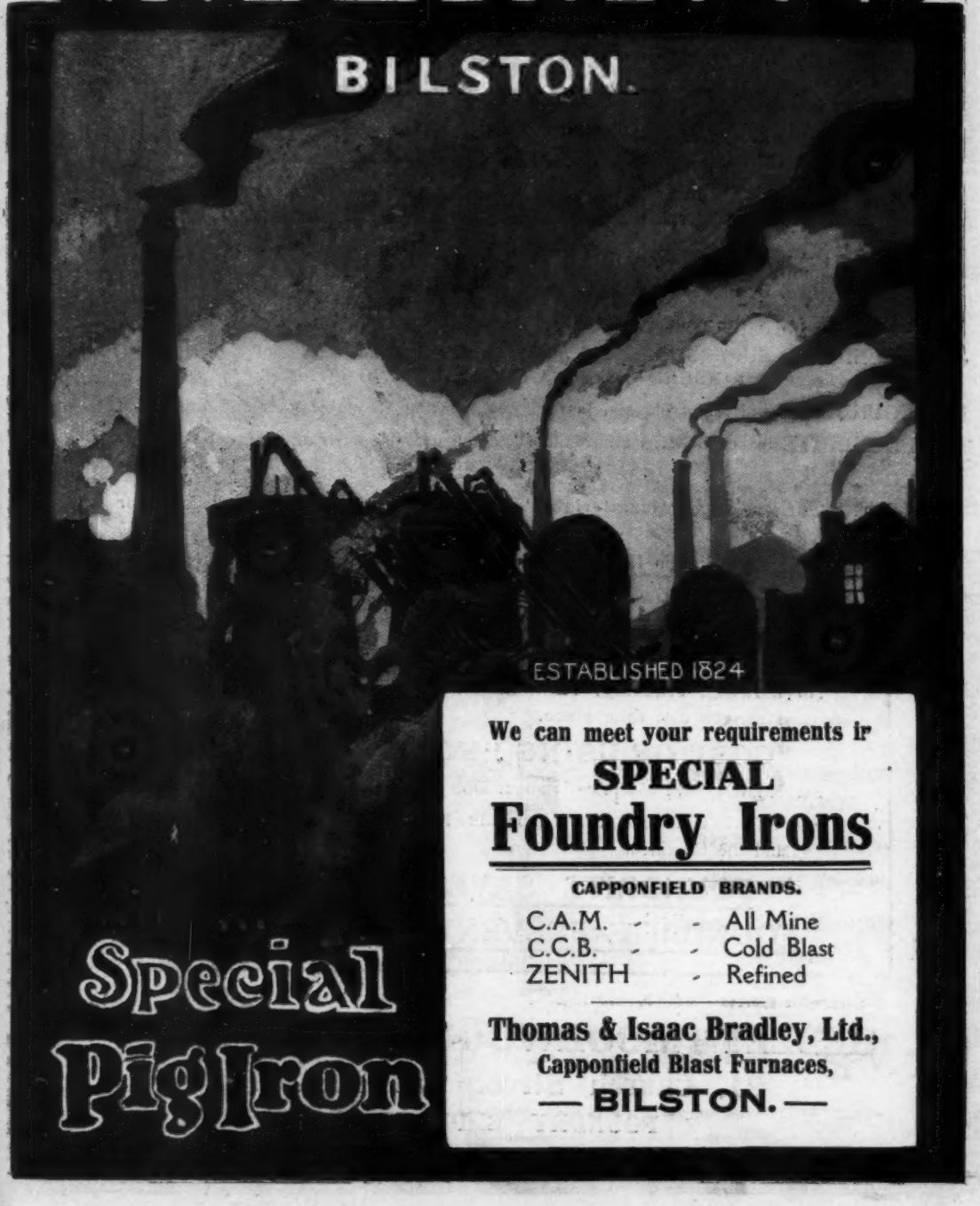

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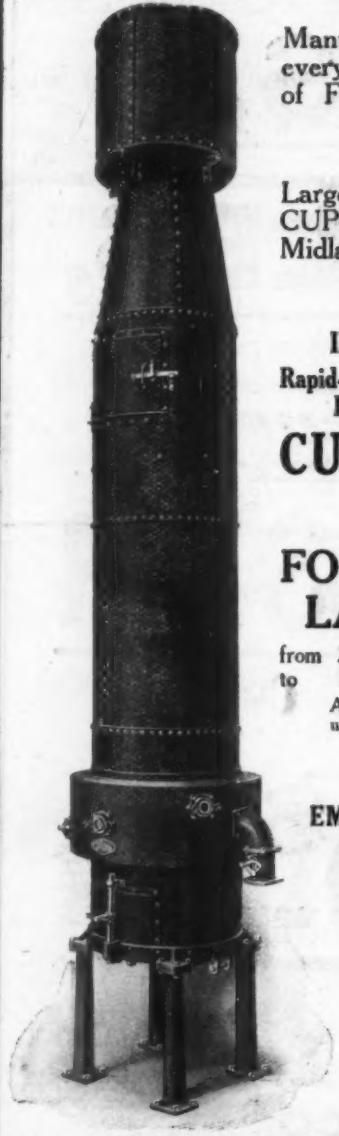

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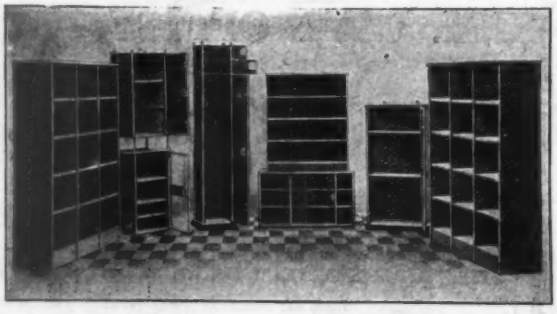

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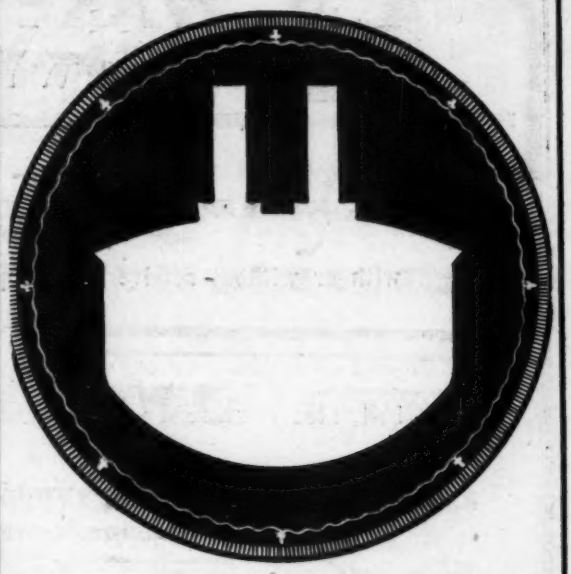

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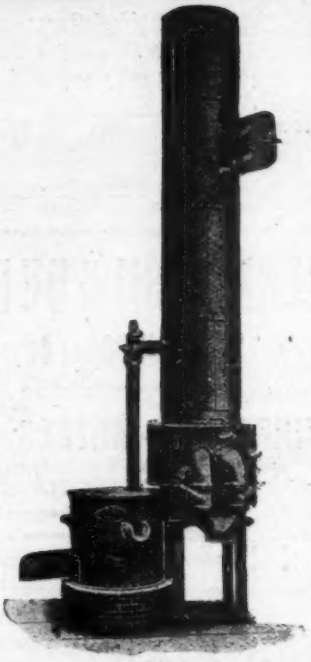

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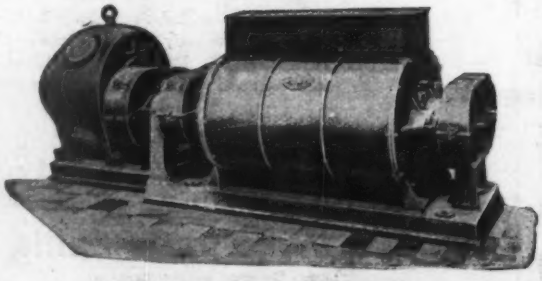

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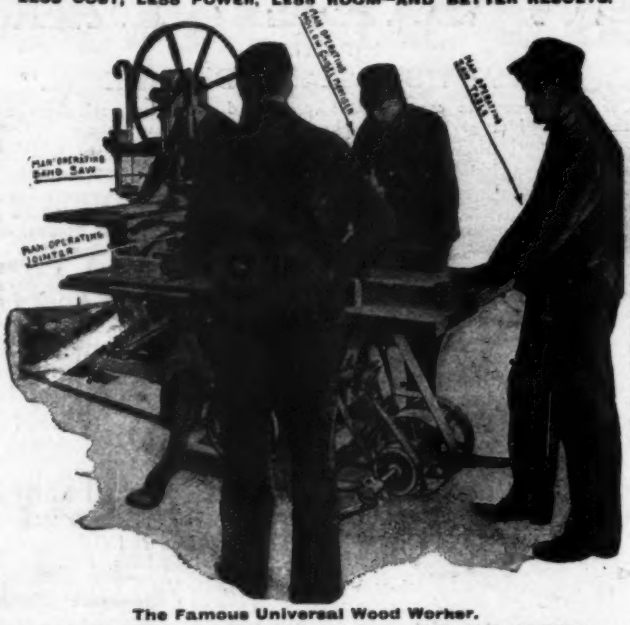

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